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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

F. E. SCHMITT, *Editor*

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Water-Pipe Problems

PROBLEMS of distributing water throughout our communities are ever with us, and are increasing in magnitude as our cities grow in size and in the intensity of their street uses. For this reason the records of experience with various types of pipe which are set down in this issue are valuable, especially for engineers of city water departments directly charged with responsibility for their maintenance, and in a less direct way to engineers in most other lines who at least occasionally are called upon to make installations of water pipes. The articles are grouped in this issue in order to concentrate attention upon the subject at a time when many engineers in the eastern part of the country are planning to get together to discuss problems related to water supply and distribution at the meeting of the New England Water Works Association in Portland, Maine.

Designing for Construction

FEW contractors have not at some time or another harbored the feeling that the engineer is a much better paper designer than a practical planner. Briefly, that he gives too little thought as to how a structure is to be put together. The charge is probably made many more times than it can be sustained, but it nevertheless is true in some measure. Occasionally a project will typify either the talent or the lack of ability of the engineer to sense his structure in the form that the contractor sooner or later must regard it, and because descriptions of such projects are published too seldom, it seems eminently proper to refer back to last week's issue to the article on the Big Four Ohio River bridge at Louisville. It is an excellent example of a structure planned for the erector. Use of timber falsework was discarded early, and the whole design was based on utilizing the existing span to support the new steel. Several facts made this plan difficult of fulfillment, chief among them that the new bridge weighed 6,000 pounds per foot, while the old bridge was designed to carry only half as much, and that the piers were not wide enough to permit erection of a new span outside of the old trusses. How it was accomplished, nevertheless, by erecting the new trusses within the old is a story which should be read by every engineer and contractor. While the particular circumstances of the case were quite individual, their appeal to the engineer's resourcefulness is remarkably stimulating. The story is of a notable construction achievement and of successful planning on the part of the engineer to overcome unusual difficulties.

Caisson Diving Bells

THE depth and pressures of pneumatic caisson work on the Vicksburg bridge described in this issue closely approach the maxima recorded for underwater foundations. The operation also was remarkably free from compressed air troubles, which is ample justification for the exceptionally well-equipped floating plant that was provided for compressed air work. In general, the Vicksburg bridge foundations exemplify excellently the command which has been attained over the hazards of high air pressures in subaqueous construction. Their great depth and high pressures offered no difficulties not anticipated and readily overcome by construction experience and engineering knowledge. A novelty in foundation work by pneumatic caissons was the conversion of one of the caissons temporarily into a diving bell to meet the conditions of a shelving bottom which had to be cut down on one side before the caisson could take a level seat and be carried down vertically by normal compressed-air sinking processes. The resort is not unique—it has recently been used by French engineers on the bridge across the Elorn at Brest—but instances of its use are rare and nowhere has it been employed at so great a depth and with a caisson of such size as at Vicksburg. The experience at Vicksburg and that of the French engineers which will be described in an article to be published soon indicate that a valuable construction device for use on occasion has been worked out on the two operations.

Water Office Buildings

WATER-WORKS administration is being put on a sounder basis every day, one contributing reason being the provision of better office facilities. The technical activities of the water engineer, as they have grown in size with the growth of cities, have created a demand for these more commodious and better arranged quarters. The business staffs, too, of the water-works companies and departments have grown in size and importance, as witness the recent formation of a finance and accounting division by the American Water Works Association; and with this growth has become apparent the need for more efficient working conditions. Finally, the convenience of the public is a factor which is being recognized when new water-works offices are proposed. Formerly the water department, though often the chief producer of city revenue, was relegated to back rooms or shoved to the top of the city hall. Water-works under private ownership have perhaps done better in office accommodation than those municipally owned. Forced to have their own quarters, oftentimes they have put up their own buildings, conspicuous examples being the Indianapolis Water Company, the Spring Valley Water Company at San Francisco and the Louisville Water Company—the latter a publicly owned enterprise administered in company form. But lately a number of publicly owned water-works have also put up their own buildings; to name only two, the Omaha Metropolitan Water District and the Detroit Water Works Board. As the need for better water-works offices gains wider appreciation, more of these structures may be expected.

Belt-Conveyor Development

THE notable installation of belt conveyors employed in building the Merchandise Mart in Chicago, as described in this issue, illustrates excellently the process continually going on in equipment production of broadening the range of usefulness of established devices. Long accepted as an economical and mechanically simple means for the continuous movement of fragmentary materials, the belt conveyor also long failed to satisfy many possible uses because of its inflexibility of position. It was stationary equipment. In concrete handling in particular the traveling belt, while a satisfactory carrier for sand and coarse aggregate and in the main for mixed concrete, did not permit of the required mobility in the line of travel and point of delivery which construction operations demanded. Inventive work began with the conception of a portable unit—a short carriage-mounted conveyor frame and belt with a contained motor. In concrete handling these were first used on large operations as lateral or branch distributors from a main line stationary conveyor. From this use there developed the use of two or more conveyors in line, each delivering to the next. The extension of thinking led naturally to the substitution of trains of portable units for long single-belt main lines. It is the last development which is represented in the concrete distributing plant for the Chicago Merchandise Mart. The conception of the belt conveyor as a train of movable self-contained units has given the concrete worker another flexible means of routing the carriage of his material and of selecting at will the point where the material can be placed to best advantage.

Manufacturers Can Help

MANUFACTURERS of construction equipment and materials have a very definite interest in reducing the turnover in contracting. This is now very large. Every contractor also who goes out of business takes with him beyond the chance of recovery a sales investment which the manufacturer has made. This in any particular case may be large or small, but in the total the money spent in educating and cultivating customers is large and often is a long time in returning through profits from sales. Obviously the longer a prospect or an old customer remains in business the better chance the manufacturer has of recovering his investment in missionary work on that potential buyer. All of which, it may be remarked, is too well known to require repetition. The reason for repetition is that it seems hard to convince manufacturers widely that they have a profitable task to perform in helping to stabilize contracting. For the better part of two years they have in large majority held back from the movement of contracting associations to stiffen credit terms in time-payment sales, which would tend to weed out of contracting those who are not fitted to succeed and continue in business. Avid for sales, they have extended credits, practiced overselling, financed new contractors and accepted repossession as a normal feature of business. Manufacturers are aware of these practices and of their vicious effect. Many of them are striving for reform and co-operating individually with organized bodies of contractors in their sales and credit stabilizing programs. In groups producing similar commodities, however, they have not co-operated largely. There is so much that manufacturers can do to help contracting practices that their indifference to the calls by contractors for co-operation is unfortunate both for themselves and for the construction industry.

Grade-Crossing Reasoning

A DECLARATION in regard to the apportionment of grade-crossing-elimination costs which is seldom heard outside of railway circles is made in the article by Professor Kittredge, published last week. It is that the benefits to users of highways are so much greater than those derived by the railways when grade crossings are removed that the public should pay directly a greater proportion of the cost than it commonly pays. The implication is that the present reluctant co-operation of the railways must be stimulated by relieving them largely of the cost of improvement. This approach to the problem holds close to precedent in ranking crossing improvement as an object for barter rather than as a requirement of economic forces.

But today the old line of reasoning no longer holds. A new approach is needed. Demagogues in public office and reactionaries in railway management have so long confined discussion to responsibility for action and expense that this instead of the right of transportation has come to be considered the controlling factor of the problem. The times demand another conception, based on the proposition that transportation has the right and will not forego the right of uninterrupted and safe movement in the service of society. This right is as true for the railway as for the highway. It is fundamental, and it will be exercised inexorably as the call for movement of commodities and people increases. Property rights and prior privileges have a place in the problem only as factors for evaluation.

In general the railways have stood immovable in the claim of superior privilege. This attitude bears fully as large a share of the responsibility for slow and halting progress in crossing improvement as does lack of ability to finance the work. It is the attitude which has provoked most of the state laws mentioned by Professor Kittredge as placing an unfair burden of crossing costs on the railways. A change of mind is required. Acceptance of the fact that the right of transportation is greater than the transportation right of the railway opens a way around most of the obstacles to crossing improvement. It ranks this work with other improvements required to serve transportation and puts it in line to be advanced as its importance to transportation is indicated. At present it is advanced or halted as the battle swings against or in favor of the railways.

In this conception the railway grade crossing has no greater privilege as an obstacle to transportation than has the blind curve or the narrow bridge. It must be eliminated because it hampers transportation by reducing safety of life and property and by limiting speed of carriage. The fact that it is the joint tool of two agencies of transportation—the public-owned highway and the private-owned railway—does not alter the requirement or make action any less inevitable. In this conception also the crossing is not sublimated or subordinated as a transportation obstacle, but takes its place according to its magnitude, which as a hazard is great but must not be magnified out of proportion.

The railway and the highway are jointly responsible for the grade crossing and for whatever obstruction it offers to traffic and for the removal of that obstruction. They are jointly responsible for its danger to travel and for the mitigation of this danger. It is no longer admissible to regard either highway travel or railway travel as outside the responsibility of both highway and railway. When each agency comes to this belief the problem of

grade-crossing improvement can be undertaken with a great difficulty overcome.

In indicating specific things required, the article by Professor Kittredge deserves careful examination. That the laws governing the financing of grade-crossing improvement require wide review and in many instances drastic modification and that protection and signaling deserve as complete development as does grade separation will not be questioned. That there should be large relief of the railways from responsibility and cost may not be admitted. They have no claim to privilege by prior right; they have obstructed action and denied responsibility wherever they could, and their argument that since the public must pay in the end it might as well pay all at the beginning is illogical and will never be accepted. Until the days of government subsidy arrive we shall need to keep railway and highway transportation costs reasonably well allocated.

Water Pipe From Source to Consumer

NEXT to the water supplied, no element in a water-works plant is more important than the pipe system. Starting at the source of supply as a single conduit a mile or a hundred miles in length, the supply main branches into and merges with the distribution system, which forms a network extending through every street in the city. This is not all. From each lateral in each street a service pipe is laid to each house and other building. The public water-works system may stop at the cellar wall, but it has not served its function until another series of branches carries water to the multitude of fixtures within the American building of today.

In number, one supply main in a given city may increase to several, each with a score or a hundred trunk distribution mains and thousands of street laterals. There may be one house connection to every five to ten inhabitants of the city and at least one fixture supply pipe per capita, thus making 100,000 or 1,000,000 or more small pipes and branches therefrom as minor but essential appendages of what is commonly called but in strict accuracy should not be called the water-works distribution system.

In size, beginning with the fixture feeds, the range may be from ½ inch to 1, 10 or 15 feet and even more.

In material and means of fabrication there is a wide and ever-increasing variety. From sources of supply to street laterals the materials used include cast iron, steel, concrete both plain and reinforced, wrought iron, and wood, each with variations as to joints, preservative treatment and its method of application. For service connections and interior piping there are cast iron, steel and wrought iron, all three of these lined with lead or with cement mortar; also lead, copper and brass.

If it were not so often overlooked, it would be unnecessary to say that upon the design, choice of materials, construction and supervision when in use of the water-works pipe system depends the water supply of our cities, towns and villages. Who controls all this? Since water service is so vital to the individual and the community, it might be supposed that control is vested in the local governing body. This is true in part, but not wholly.

The first exception that will be noted is the piping and fixtures within buildings. Subject only to possible municipal regulation of plumbing, owners of buildings served with water put in such pipe and fixtures as they choose or as their architect or their plumber chooses. This is true in the United States and, perhaps in less degree, in Canada. It is in striking contrast to the strict requirements of British cities, some of which go so far as to test fixtures before permitting their installation.

In coming to the house or service connection, a larger degree of municipal control is practiced, but with wide variations. First, there is diversity in ownership of the service connection. In the absence of exact information, one can only record a strong impression that from the street lateral to the curb or some other dividing line the municipality, and from that line to the building wall the property owner, installs and pays for the service connection. Sometimes where the property owner pays for the service the city decides what material shall be used and may install it at private expense, while sometimes the city dictates the size and material of the service, even though it is furnished and laid by the property owner. Number of cities and total length of services considered, the conclusion seems warranted that the property owner rather than the city supplies and lays house connections, acting through a plumbing contractor.

The foregoing remarks about service connections and building fixtures are based on municipally owned water-works. Where the works are privately owned, conditions appear to be much the same as to service connections except that private companies have no direct and little delegated power of municipal control. They have varying degrees of power through their rules and regulations—but in many if not most states these are subject to approval by utility commissions. Inside of buildings privately owned water-works have little control.

Control of choice of pipe materials and methods of construction from street lateral to supply main lies in the owner of the works, public or private, with limited degrees of city and state control where the works are privately owned and with still more limited state control in the case of municipally owned works.

There should not be overlooked an indirect, unofficial but important element of control over water pipe from source not only to the laterals but also to many of the service and some of the building-fixture connections: fire insurance underwriters and the factory mutual companies. This control or influence embraces both material and size. In Texas quite recently an unprecedented instance of state control through the insurance department created a sensation, the department penalizing the use of steel pipe. Here and there state health departments attempt to exercise more or less direct control over water pipe in passing upon applications for the approval of new or additional water supplies.

This confessedly sketchy review of water pipe from source to consumer is designed chiefly to give those outside the field of water-works engineering and operation a birdseye view of the importance of water pipe, large and small, and to hint only at the many problems that enter into the choice of pipe. To the water-works engineer and operator the review may bring to mind aspects of the subject often overlooked in the pressing routine of daily practice. The only one of these which we wish to emphasize further is that the supposedly responsible authorities do not control all the pipe that enters into the efficiency of the water-works plant, since full control would cover the thousands of service and fixture connections.

Finally, it may be noted that a number of the technical points entering into current water-pipe practice, both in the United States and Great Britain, are touched upon, some in considerable detail, in several articles purposely brought together in this issue.

Cast Iron, Steel or Reinforced Concrete?

Fifteen Years' Experience With Large Water-Supply Pipe Lines in Hartford, Conn.

By Caleb Mills Saville
Manager and Chief Engineer, Water-Works, Hartford, Conn.

From Coast to Coast, wrought iron and steel have been used for large water-supply mains for many years. In the last decade or two reinforced-concrete pipe has come on the scene. These materials have contested the field with cast iron, which claimed advantage in longer life and larger carrying capacity. Substitutes for riveted joints gradually put steel carrying capacity on a par with cast iron, while concrete was on par from the start and had an advantage over both steel and cast iron when the pipe to be selected was to carry a water that would cause tuberculation. Because of these differences between the several materials it was necessary, in planning a new main, to set up various differentials covering longevity and carrying capacity. The case was further complicated when cement-mortar lining was developed for steel and for cast-iron pipe. How these changing conditions have been met by a progressive engineer and his water board is shown by Mr. Saville's article on fifteen years' practice at Hartford, Conn.

—Editor.

"Be not the first by whom the new is tried,
Nor yet the last to lay the old aside."
Pope: Essay on Criticism.

WHEN contemplating an improvement which not only will require investment of a large sum of money in first cost but also may bring about considerable expenditures for maintenance and replacement, it is desirable and necessary to consider such facts as may be, so that the ultimate installation may prove as economical and efficient as possible. This applies to all parts of a water-works system, including the pipe, which make up so large a percentage of the total investment. This article will deal with the choice of material for large water pipe, particularly mains from sources of supply to the distribution system. Most of the discussion will relate to experiences at Hartford, Conn.

Large water-supply mains are usually constructed of cast iron, steel or concrete reinforced with steel. For purposes of economy, they should be made as small as will provide the required capacity, with due regard to the future. The relative capability of pipe lines of different characteristics to meet local requirements, in general, is based upon the following: (1) relative degree of smoothness of the pipe line when first laid; (2) reduction in carrying capacity due to age of the pipe; (3) deterioration of the pipe line itself due to corrosion from both within and without; (4) first cost; (5) maintenance cost; (6) replacement cost after a term of years.

It is self-evident that of two pipe lines of the same internal diameter that which has the smoother interior surface will carry the greater quantity of water under otherwise similar conditions; also that, for the delivery of the same quantity of water, that pipe which has the smoother interior may be of less diameter than any other.

In comparisons of carrying capacity of pipe of different degrees of smoothness it is customary to use what are called coefficients of roughness—that is, figures based on experience which, when applied to the general formula for obtaining flow in pipes, will give what are considered to be the relative handicaps due to different degrees of smoothness of interior. In "Hydraulic Tables," by Williams and Hazen, it is stated that "in making estimates for pipe lines where the carrying capacity after a series of years, rather than the value of the new pipe, is the controlling factor, a considerably lower value of C must be used, depending upon the amount of deterioration which is contemplated."

30-IN. REINFORCED-CONCRETE PIPE DISTRIBUTED ALONG DITCH READY FOR LAYING

Case I A. Upper Nepaug Conduit: Cast-Iron Pipe Wins

In 1913 the Board of Water Commissioners of the city of Hartford, Conn., had under consideration the construction of a water conduit from its Nepaug reservoir, near Collinsville, to its filter plant in West Hartford, a distance of about 10 miles. For 9 miles of this distance a pressure pipe seemed best and for the remainder of the way cut-and-cover aqueduct, tunnel and reinforced-concrete conduit. The pipe-line work was in two sections. The westerly portion was about 8 miles long, and for it proposals were received for both cast-iron and steel pipe. For the easterly portion, a 48-in. lockjoint reinforced-concrete pipe was installed some time later. Prior to making up the call for bids for the metal pipe portion, considerable thought was given to the matter of equivalent values of the two materials, as applicable to the work in hand. It is pertinent to interject that it is improbable to find conditions so exactly the same in two contracts as to warrant bodily transference of the requirements of the specifications for work in one location to another, and it is usually indicative of ignorance, lack of judgment or laziness on the part of him who does this trick.

Bids on this 8-mile line were requested for furnishing and installing 44-in. riveted steel, 42-in. lock-bar or welded steel, and 42-in. cast-iron pipe. In comparing bids for the award of this contract, an addition of 15 per cent was made to the prices for all classes of steel

pipe. This was considered, *for the purposes of this award only*, as the resulting difference in value between steel and cast-iron pipe, taking into account durability, reliability, leakage and other pertinent factors. The relative values of cast iron and steel for Hartford conditions were carefully considered at this time (1913).

Capacity was taken care of by increasing the size of steel pipes to allow for interior conditions. For durability and maintenance, steel pipe was held to be somewhat inferior to cast iron, and for leakage there seemed little to choose. Steel was considered more reliable than cast iron under conditions which would produce breaking. For this particular line, however, this matter was not serious, because the country passed through was sparsely inhabited and damage by breakage would not be of special importance. This country also was mostly of a free draining gravel or sandy nature, and thus particularly well adapted to the use of steel pipe.

In the report made in June, 1913, upon the relative merits of the two materials then under consideration, it was stated: "There is also the feature of new materials to be considered for conduits, and the possibility that a form of construction may be developed in the next decade which will have all the advantages of cast-iron pipe in regard to durability combined with the lower first cost of steel pipe. Reinforced concrete would meet this condition, and the use of that mode of construction, which has recently been made in this country and abroad in long pipe lines under considerable pressure, is sufficient to indicate that such pipe must at least receive careful consideration."

Since that day reinforced-concrete pipes have thrust themselves into the market and now, instead of steel against cast iron, as in 1913, steel and cast iron are combined against a now common enemy—reinforced concrete. Some of the methods of attack that have passed under notice have been by specious propaganda and "jockeying for position" rather than by endeavor to turn out a product whose intrinsic worth would enable it to compete effectively.

COMPLETED LINE OF 30-IN. REINFORCED-CONCRETE PIPE

On the basis of the conditions noted above, which were included in the specifications, the contract was awarded for the installation of a cast-iron line. Flow tests of this line in 1927, or thirteen years after the pipe was first put into service, were very carefully made and resulted in a coefficient C of the Williams-Hazen formula of 98.9. The coefficient C given in the Williams and Hazen "Tables" (third edition, p. 43) for 42-in. pipe, is 110 for twelve years, 100 for twenty years and 90 for 30 years.

Case I B. Lower Nepaug Conduit: 48-In. Precast Concrete

In 1918 the last section of the Nepaug conduit was built. It consisted of a 48-in. precast reinforced-concrete pipe line about a mile long, alternative bids being received for a reinforced-concrete pressure conduit built in place.

Case II. Reinforced Concrete Wins Against Cast Iron and Steel

In 1927 a pipe line about 3 miles long was desired for connecting up two important reservoirs (Nos. 5 and 6) in order to obtain better service. Here conditions were entirely different from the case of 1913, for although the location was at that time practically uninhabited, the material passed through and the water to be carried in the pipe line was of an entirely different character—"aggressive" conditions both within and without. Experience with similar conditions elsewhere in the system had shown that steel pipes buried in the ground for water service work were destroyed within a decade or so from attack within and without and cast-iron pipes of the ordinary tar-coated variety had their capacities greatly reduced by tubercles.

In order to get proposals covering as wide a range of materials as possible and at the same time set up what was thought to be a reasonable standard for comparison of bids, proposals were called for five different kinds of pipe: 30-in. cast-iron, 30-in. reinforced-concrete, 36-in. steel, the latter welded, lock-bar or riveted.

A rather careful investigation of practice elsewhere indicated that, with Eastern upland waters at least, many engineers had found very little difference in the carrying capacity of steel pipes of whatever fabrication, after a comparatively short term of years. Local experience with cast-iron pipe indicated that it, too, would probably deteriorate considerably in carrying capacity, but as it was the almost universal material in the pipe system up to this time, and as the labor force was accustomed to this kind of pipe, it seemed proper to take it on the same diameter as reinforced concrete, the lining of cast-iron pipes with cement then not having reached its present stage. For durability, a life of 50 years was assigned in computation for handicap factors for comparison of steel pipe, with longer lives for cast-iron and reinforced-concrete.

Basis for Comparing Bids—For the comparison of bids only, and for the purpose of making what are deemed proper allowances, in so far as *this particular pipe line* is concerned, for differences in durability, capacity and workability of the pipe lines made of the several materials listed above, the prices bid were multiplied by the following factors and comparison for award

of the contract was made on the basis of the results obtained after application:

For 30-in. reinforced-concrete pipe	Multiply by 1.00
For 30-in. cast-iron pipe	Multiply by 1.15
For 36-in. steel pipe	Multiply by 1.10

The differentials were decided upon after careful consideration of the conditions of the locality and the experience gained in operating the works. It was felt that reinforced-concrete pipe was most suitable for installation, but it seemed possible that if bids on concrete pipe only were asked for, there would be criticism, and statements might be made that some other kind of pipe could be installed more advantageously. It was felt that this criticism would be more difficult to meet satisfactorily *after* bids were received. Bids were called for therefore on a basis which seemed to provide that the board would get equal service no matter what kind of pipe was installed, and the handicap was built up as follows:

HANDICAPS FOR COMPARING BIDS FOR WATER PIPE OF VARIOUS MATERIALS AT HARTFORD, CONN.

	Reinforced Concrete	Cast Iron	Steel
Size, in.	30	30	36
Assumed life, years	75	100	50
Annual annuity required to amortize at 4 per cent interest compounded annually, per dollar of first cost	0.00224	0.00081	0.00658
Annual annuity per dollar of first cost as above, capitalized at 4 per cent (coefficient for *durability*)	0.06	0.02	0.16
Coefficients for flow assumed for Williams and Hazen's formula	130	100	80
Carrying capacity on basis of 2.5 ft. drop per 1,000 ft. (16,000 ft. of line El. 400 to El. 360), m.g.	15.93	12.24	15.77
To reduce the cost to the basis of the same carrying capacity for each kind of pipe, multiply each dollar of first cost by (coefficient for *capacity*)	1.00	1.30	1.01
Sum of durability and capacity coefficients	1.06	1.32	1.17
To allow for the fact that cast iron is more readily tapped and can more readily be repaired and handled by the water board organization which is more familiar with cast iron than other materials, the cast-iron handicap was arbitrarily reduced by		0.10	
On this basis, coefficients are	1.06	1.22	1.17
Making concrete pipe unity, the coefficients reduce to, per cent	100	115	110

For the purpose of comparing bids, 15 per cent is to be added to the bid price for furnishing and laying 30 in. cast-iron pipe and 10 per cent for steel pipe.

Precedents—In its contract 54 (1926) the Metropolitan Water Commission (Boston, Mass.) gave the alternative of 24-in. cast-iron, cement-lined, or 30-in. steel.

In Providence, R. I., 1924-5, the Water Supply Board gave an alternative of 6 in. in diameter—that is, 60- and 48-in. precast concrete pipe or 66- and 54-in. steel pipe.

In Washington, D. C., the U.S.A. Engineer Corps (1925) for the "second and third high pipe lines" (Specifications, p. 17), for purposes of comparison of bids, mentioned that any of the following kinds of pipe would be acceptable; cast-iron, welded steel, lock-bar or riveted steel and reinforced-concrete. Comparing durability, a life of 100 years was used for cast-iron, 100 years for reinforced-concrete and 50 years for steel pipe; and on carrying capacity used on the basis of the Williams & Hazen formula, *C* equal to 100 for cast-iron and steel pipe and *C* equal to 130 for concrete pipe.

It is also stated in these specifications that "riveted steel pipes will be made 2 in. larger diameter than other kinds of pipe to make their carrying capacity approximately the same as cast-iron or welded steel pipe."

Durability—From Williams and Hazen's "Hydraulic Tables," p. 22: "Most pipe in actual use is of iron or steel, and such pipe always deteriorates in carrying capacity with age. The rate of deterioration depends upon three conditions: (1) the quality of the metal; (2) the excellence of the pipe coating; (3) the quality of the water." At the top of the second column in the "Tables" are figures "inclosed in circles, representing the ages in years at which it is supposed on *an average* iron pipes would reach the coefficients indicated. These are intended to serve as a warning to the estimator of reduced capacity to be faced with age, and as a guide in making allowance for it." Also, "large deviations from indicated rates of reduction in carrying capacity are found in individual cases."

Deterioration of Metal Pipes—It is a well-established fact that cast iron is much more resistant to corrosion than is steel, because of its physical characteristics. Up to the present, no pipe coating has been developed that has retained its original resistant qualities for fifteen or twenty years, to say nothing of permanency. Cast iron, under certain conditions, will become coated on the inside with rust tubercles, but is practically immune from serious deterioration that will affect the pipe walls, except in special cases such as salt marsh or continual ebb and flow of tidewater.

Coating—To Mark Twain is credited the remark, "A great deal has been said about the weather, but nothing has ever been done about it." This remark might apply with equal force to pipe coating. If the large pipe manufacturers were as eager in their search for a coating that really protects as in their endeavors to sell pipe at a profit, it might be that profits also would increase to present concerns that now bewail the advent of new materials which the user must seek in self-protection.

It is on record that uncoated steel pipe will rapidly deteriorate, both inside and outside, if exposed to water or soil containing some kinds of chemical or vegetable constituents.

It has been found practically impossible to keep the shop coating on the outside of steel pipes intact during construction, on account of necessary requirements of handling, and both inside and outside coating is completely removed at the joints due to heating while field riveting. The abrasions that result are treated with liquid coating which can be applied in the field, but the coating at these places is seldom or never as permanent as that applied at the shop.

Many instances of serious rusting in steel pipes are of record: Portland, Ore., Rochester, N. Y., Akron, Ohio, among others.

Aggressive Waters—As to the effect on the pipe of the character of the water, some waters are very aggressive in their ability successfully to attack unprotected iron and steel and the latter is much more susceptible than the former.

Experience with the waters from the eastern slope of Talcott Mountain of the Hartford system has shown them to be particularly active in their attacks on iron and steel. Cast-iron pipes have been badly corroded on the inside with a rough coating of rust an inch or so thick, and the use of steel service pipes was abandoned in Hartford some years ago because their useful life was found to be not over eight or ten years.

In 1912, prior to cleaning them, the coefficients of flow were determined for the 30-in. and north 20-in. lines, 24,000 ft. in length, leading from Reservoir No. 1 to the city, with the following results:

	When Laid	1912	Williams and Hazen Coefficient According to Age	Coefficient New Laid or Cleaned	Age in Years As Per Observation	Age in Years Actual
30-in.	1896	85	105	130	36	16
North 20-in.	1875	70	83	130	60	37

In 1926 a flow test of the 30-in. main showed: Coefficient established, 61, for W. and H. formula. Actual age pipe line, 30 years; equivalent age as per observation, 70 years. These later figures indicate a reduction in carrying capacity of about 28 per cent in fifteen years (1912-26) due to local conditions. After this test the 20-in. pipe was scraped clean of incrustation and the original carrying capacity nearly restored.

The record of 1912 shows that the actual carrying capacity of the pipes carrying Talcott Mountain water suffered considerably more reduction than the average given for the same age in the W. and H. "Tables." The condition of the 30-in. main was comparable to the average pipe twenty years older, while the north 20-in. had the characteristics to be expected in a pipe 23 years older.

The coefficient $C = 80$ (see large table) used in the 1927 call for bids on the steel alternative seems justified by the experience stated above and is checked as follows:

	Years
For average cast-iron pipe line, age (W. & H. "Tables")	20
W. & H. "Hyd. Tables" state (p. 3) that "Steel pipe of a given age will carry the same amount of water as cast-iron pipe of the same size" older by	10
Experience with water from Hartford reservoir No. 6 water warrants an additional excess of averages of at least	20
Total age to be considered	50

Williams and Hazen's "Hydraulic Tables" for pipe 50 years old give $C = 75$; on this basis, coefficient $C = 80$ used in making up the differentials does not seem to be "antagonistic to steel pipe" nor does it appear that "all established engineering principles have been set aside by penalizing steel pipe."

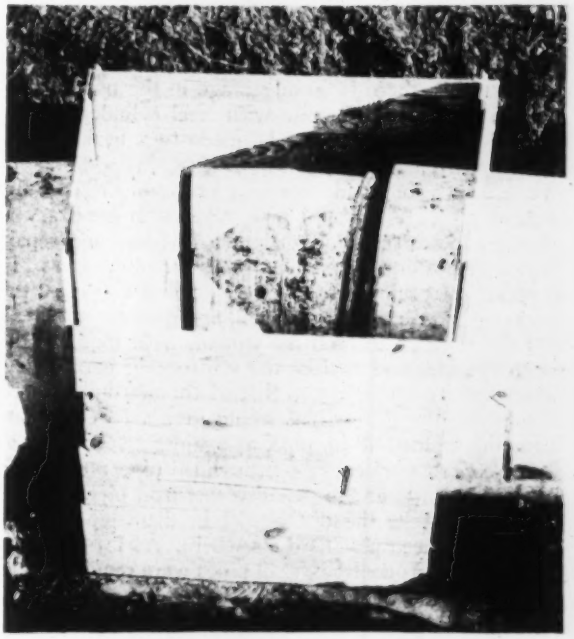
In designing a pipe line costing upward of $200,000 it would seem unwise to provide for less than the required capacity twenty years hence, and the importance of such a line in a public water-supply system seems to call for conservative rather than optimistic judgment.

Case III. 36-In. Reinforced Concrete With Steel Cylinder Embedded

The third water-supply conduit to be considered is that for which a contract was awarded to the Lock Joint Pipe Company, of Ampere, N. J., late in July, 1929. To avoid the discussions and quibblings that have often arisen as to the proper coefficient to apply for estimating capacity and as is of record when the pipe line just described was built, it was deemed advisable to put all pipes so far as possible on the same basis as regards this matter. To accomplish this purpose, all pipes were required to have net diameters of 42 in. or 36 in. (for different parts) and to present a smooth mortar surface to the flow of water except in the case of the unlined cast-iron pipe.

Steel and concrete pipes could meet this condition without difficulty. For cast-iron pipes, it was provided that all pipes of this material should be made with Class D outside dimension (A.W.W.A. Specifications) and with Class B thickness for part of the line and with Class C thickness for the remainder of the line. The cement lining was to be applied by the centrifugal process, with a peripheral speed of 600 revolutions per minute. The pipe was to be protected outside with an asphalt coating, brushed or sprayed. The cement lining for 36-in. and 42-in. pipe was to have a thickness of $\frac{3}{8}$ in., with a tolerance of $\frac{1}{16}$ in.

The specifications for reinforced-concrete pipe require that it be of the so-called cylinder type, consisting of a sheet-steel cylinder covered externally and internally with layers of dense concrete, in which reinforcing steel is embedded. The pipe is to be made by a manufacturer who, for a period of at least five years, has produced reinforced-concrete pipe of the type, sizes and quality specified and whose product has been in successful use on projects of considerable magnitude in the United States.



A SPECIAL IN 30-IN. CONCRETE PIPE READY FOR POURING

The wall thickness of the pipes is not to be less than $4\frac{1}{2}$ in. The concrete wall is built up around a cylinder of blue annealed steel sheets, commercial grade, of thickness not less than No. 14, U. S. Standard Gage, formed with lap welds. The cylinder is for the purpose of water stop only, and is to be tested under air pressure of at least 25 lb. per sq.in., made satisfactorily tight.

The inner layer of concrete is to be reinforced with steel-mesh fabric and the outer layer with a series of transverse and longitudinal bars welded together to form a cage. All of the internal water pressure is to be carried by this reinforcement, without stressing the steel over 12,000 lb. per sq.in. under test pressure, which is considerably in excess of normal requirements. In design, the inner layer of reinforcement and the steel cylinder were not considered as taking any of the tensile stress due to water pressure.

The concrete of the pipe walls is to consist approximately of 1 part cement, $1\frac{1}{2}$ parts sand and $2\frac{1}{2}$ parts of stone or gravel, using proper amounts of water and with provision for placing the concrete and curing the pipes when made, special care being taken to insure a smooth and durable interior surface.

To give unlined cast-iron pipe a chance, provision was made for an alternative proposition for supplying unlined cast-iron pipe 48 in. in diameter, with ordinary tar coating within and without. This was done as a concession to the condition that the pipes in the supply system were cast iron and the maintenance force was familiar with this material.

On the other hand, it was considered that steel and reinforced concrete have an advantage over cast iron for pipe material in high-value districts, because, in case of break, no sudden explosion occurs whereby a large section of pipe wall is blown out, with consequent

damage to property; a very serious circumstance in pipe lines of large size, both as to damage and as to sudden interruption of service over large districts.

Besides this, there is an advantage in the use of steel pipe and reinforced concrete with steel cylinders in the ease with which repairs can be made to a broken pipe. With cast-iron mains of large size, in addition to damage, it is a long and expensive process to replace the damaged pipe. With steel pipe, all that is necessary is to bring a portable welding plant to the site and repair the pipe in position—a comparatively simple process. In the case of reinforced-concrete cylinder pipe, the process of repair would be similar—namely, to break away the concrete around the wound, weld together the broken cylinder and replace the reinforcing bars.

For capacity equivalent to that of the mortar-surfaced 42-in. pipes, the differential would give a coefficient of 90 for the unlined 48-in. pipe, as against a coefficient of 130 for concrete or cement-mortar-lined pipe, a condition that does not appear "to penalize cast-iron pipe" too severely and checks the differential in diameter between lined and surfaced pipe used elsewhere. As for the other provisions of this contract, steel pipes were required to be wrapped on the outside with "Pabco" as a safeguard against exterior deterioration. This method has been in successful use in the West for some years.

The term "Pabco Soil Proof Wrap" is the trade name of a coating for steel pipes made in San Francisco, Calif. It consists of rag felt, made of selected mixed cotton and woolen rags and burlap, pulped and molded into a sheet of clean fabric or felt. This felt is thoroughly saturated with a bituminous solution and an asphalt coating is applied to both sides of the saturated felt. The total weight of the finished covering is about 40 lb. per 100 sq.ft., and its tensile strength not less than 55 lb. per inch cross-section.

The wrapping extends to within about 5 in. of the end of each section of pipe and is sealed to the pipe with hot dip. After the steel pipes are riveted together in the trench, a strip of covering, long enough to give a 6-in. circular lap, is run around the joint. While the exterior coating of the felt is in a plastic condition, flaked mica is applied in quantities to give best results.

As for lining the steel pipes, it was provided that the mortar could be placed either by the centrifugal process before laying or by the use of an inside form after laying.

This pipe line is about 19,000 ft. long, and, for the most part, along heavily traveled highways and through a thickly settled district; 16,925 ft. of it was designed for 42-in. cement-mortar-lined pipe or 48-in. ordinary cast iron; 2,075 ft. was designed for 36-in. cement-mortar-lined or 42-in. ordinary cast-iron pipe.

Total Bids Compared—Eight proposals were received for furnishing and installing the pipe. The contract was awarded to the lowest bidder, the Lock Joint Pipe Company, Ampere, N. J., for a reinforced-concrete pipe with interior cylinder. The proposals were as follows:

Reinforced-concrete pipe, Lock Joint Pipe Co.	$369,204
Cement-lined cast-iron pipe, Barbara & D'Aurio	399,239
48 in. A.W.W.A. cast-iron pipe, Barbara & D'Aurio	420,658
Cement-lined steel pipe, O'Neil Bros.	469,494
Cement-lined steel pipe, A. W. Bryne & Son	521,725
Cement-lined cast-iron pipe, A. W. Bryne & Son	533,950
Reinforced-concrete pipe, Montrose Contracting Co.	570,176
Cement-lined steel pipe, Montrose Contracting Co.	656,040

Detailed bids are given in tabular form on Construction News page 132 of this issue of *Engineering News-Record*.

As before stated, these specifications were drawn solely to meet local conditions and are not presented in any way as a standard nor do they purport to be an advance in practice. Under other conditions, and perhaps ordinary conditions, steel, cast-iron and reinforced-concrete pipe, as commonly presented by makers, would be sufficient and to be desired on account of considerably decreased cost. Standard designs of pipe makers were not used on this contract, merely because local conditions of several kinds seemed to warrant slight modifications. The cost of the work was somewhat increased thereby, but the results are expected to justify the expense.

As indicative of advancement in the art of pipe making and the accumulation of experience all over the country, it is interesting to note that in 1913 good practice compared 42-in. pit-cast-iron pipes with 44-in. riveted steel pipes, both of ordinary make and coating, and put a differential of 15 per cent in favor of cast-iron over steel for durability.

In 1929 42-in. cement-mortar-lined pipes of cast iron or steel, together with pipes of reinforced concrete, are compared with 48-in. pit-cast pipe with ordinary tar lining for capacity. For durability, supercoated steel pipes, those of reinforced concrete, and possibly pipes of cast iron fabricated by newer processes that do not depend upon annealing for protection against brittleness, are now being looked to in the larger sizes as a relief, so far as longevity in service is concerned, because of the attitude and inertia of some of those companies which make cast-iron pipe in the larger sizes.

Already there are rumblings that at least some of the important cast-iron pipe manufacturers are progressive, and of their own initiative, instead of being pushed out of old ruts, are breaking away from the attitude "The public be damned" and "What was good enough for father is good enough for you."

The Present Outlook

It certainly looks as if in the future the users of large pipe will have their innings, whereby they might have an opportunity for choice that would give reasonable assurance of both capacity and durability. Apparently cast-iron pipe manufacturers, as well as others, should remember that

> There is a tide in the affairs of men,
> Which, taken at its flood, leads on to fortune;
> Omitted, all the voyage of their life
> Is bound in shallows and in miseries;
> * * * * * * * * * * * * * * *
> And we must take the current when it serves,
> Or lose our ventures.
>
> *Shakespere: "Julius Cæsar."*

It seems quite evident that some of the larger cast-iron pipe makers seem to place more dependence on specious propaganda than in catching the tide of progress at its peak in an endeavor to improve product. This method involves less expenditure of capital, but its ultimate value is at least open to question.

British Study of Steel Design Planned

In the belief that much structural steel work is needlessly expensive in design, a committee has been organized in England to make an exhaustive study of the economic use of steel in buildings, according to a note appearing in *Engineering* (London). The work, which will be financed by the British Steel Works Association and the Department of Scientific and Industrial Research, will extend over five years and will cost about £4,000 annually. The committee will be composed of representatives of the two bodies financing the investigation, and also of the Institution of Civil Engineers. It is expected that the ultimate result will be the preparation of standard specifications for steel design.

British Water-Pipe Practice and Experience

Observations From an Editor's Notebook

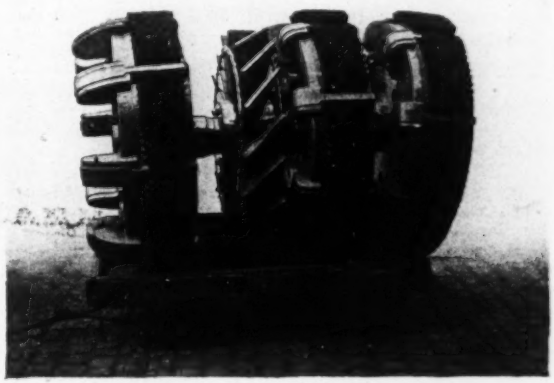
Steel With Spun-In Bituminous Lining and Spun Reinforced Concrete Are Displacing Cast Iron for Large Supply Mains—Welded Longitudinal Joints and Leaded Bell-and-Spigot Ring Joints Used for Steel Pipe—Breaks in Cast-Iron Pipe Attributed to Temperature and Vibration

By M. N. Baker
Associate Editor, Engineering News-Record

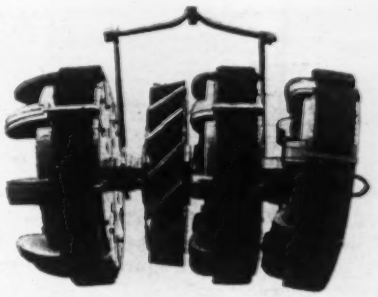
"IN WATER-PIPE practice Great Britain is ahead of the United States," said a consulting engineer familiar with water-works in both countries, just before I sailed for England. This strengthened my intention to inquire about materials used for pipe and pipe coating, character of joints and experiences with pipe breaks.

For distribution mains I found that cast-iron pipe with bell-and-spigot joints is almost the sole dependence, as in America, but for trunk distribution mains and longer conduits from source to city other materials are gaining rapidly in use, as is also the case in America. Steel seems to be the most general substitute for cast iron in Britain, with spun or centrifugally-cast reinforced concrete second. If wood stave pipe has ever been used in England and Scotland I have never heard or read of it. Spun cast-iron pipe appears to be used only sparingly as yet. Coating for cast-iron pipe is almost always described as Dr. Angus Smith coating, the coal-tar compound introduced nearly a century ago. Changes in gas-works practice seem to have affected this coating adversely in England as in America. For coating steel pipe, bituminous material is generally used; spun-in rather than applied by dipping, most of my informants stated. This for the inner coating or lining. Outside, "Hessian," soaked in bituminous material, is quite generally used as a wrapping.

Jointing material for cast-iron pipe is almost always lead, run in hot; I heard of one or two cases of the use of lead rods. I cannot say positively that riveted steel pipe is never used in England, but always I was told that longitudinal joints were welded. Circumferential joints in steel water mains appear to be most commonly of the hub-and-socket form, lead calked.



WHALEBONE PIPE CLEANER USED ON UPPPER PORTION OF VYRNWY AQUEDUCT
Water pressure forces the cleaner through large pipe above filtration plant.



ANOTHER VIEW OF THE BIRMINGHAM PIPE CLEANER
This view shows flexibility of the cleaner better than does the first view.

Breaks in cast-iron distribution mains seem to be less common in England than in America (perhaps because large sizes are less common there than here), but some cities have had many troublesome breaks in large cast-iron supply mains, due, in the cases of which I heard, either to "active" water attacking the pipe or to settlement. Concrete bedding of cast-iron mains in poor ground, and concrete bracing at bends, were spoken of by several, both as actual practice in specific instances and as an ideal.

The following notes are based on interviews with officials in control of water-works and consulting engineers in water-works practice in Great Britain.

Attitude of Ministry of Health and Two Consulting Engineers

A conservative attitude on the use of material other than cast-iron for water pipe was expressed in a brief interview I had with E. A. Sandford-Fawcett, chief engineering inspector to the Ministry of Health, under whose jurisdiction is the approval of permanent loans for municipal purposes. Apparently steel pipe would be permitted, if lined with spun-in bitumen, but not with dipped coating; in clayey soil, external wrapping would be needed. An opinion adverse to reinforced concrete for pipe, and to that material generally where exposed to moisture, was expressed by Mr. Fawcett.

Use of steel pipe for large water-distribution mains is just beginning, in the opinion of Herbert Lapham, consulting water engineer, Westminster, London. Both cement mortar and bitumen are being used for lining; spun cast-iron pipe, some of it cement lined, is being used. Few breaks occur in British water-distribution systems, Mr. Lapham believes. In laying cast-iron pipe

great care is taken to guard against movement. To that end, concrete is used at bends and for bedding.

Another London consulting engineer, H. F. L. Gourley, a partner in Sir Alexander Binnie & Son, uses steel for water-supply mains and has recently completed such a conduit for Singapore, S. S. It is 35 miles long, divided equally among diameters of 39, 36 and 33 in. The pipe was fabricated in Britain, nested and shipped by water to Singapore and on arrival there was lined with 1½ in. of cement mortar. On another job, this one in England, cast-iron pipe was used to convey a water naturally "active." The water is treated with a small amount of lime to prevent injury to the pipe.

"The day of cast-iron pipe for large mains is over," said one consulting engineer, and another remarked that the "use of steel pipe for large water-distribution mains is just beginning." These are among the notable opinions of engineers and the facts as to practice gleaned by Mr. Baker in a recent visit to England as reported in these notes. —*Editor.*

Practice in Various Cities

London District—Pipe practice of the London Metropolitan Water Board was outlined to me by C. F. Marsh, deputy to Henry E. Stilgoe, chief engineer to the board. As a rule, cast-iron pipe is used in the distribution system, up to 48-in. requirements, and steel above that, the largest steel pipe, Mr. Marsh thought, being 66 in. Some old cast-iron pipe as large as 54 in. is in use. In clayey London soils cast-iron pipe sometimes becomes so soft ("graphitic") that it can be cut with a knife. This was formerly attributed to electrolytic currents due to inequalities in the potential of the iron, but studies now in progress seem to show that the softening is caused by "clay bacteria." It has been necessary to replace long stretches of attacked pipe. In clayey soils, cast-iron pipe is now surrounded with gravel when laid. Aside from failures due to softening, there have been breaks in cast-iron pipe attributed to temperature changes in the water. These are confined to pipe conveying river water; part of the supply is from wells. Turned-and-bored pipe joints are no longer used on the London Metropolitan Water-Works. Spun cast-iron pipe has been used, but not extensively; some of it has been lined with cement mortar and some with bitumen. Reinforced-concrete pipe as large as 50 in. has been used, subject to pressure up to 50 lb. Steel pipe is coated by a hot bituminous dip, then covered outside with two layers, and quite recently three, of Hessian, also dipped in bitumen.

Lead pipe is used for house service connections; but within buildings, above ground, other material is permitted.

Liverpool—"The day for cast-iron pipe for large water mains is over," said J. R. Davidson, water engineer of Liverpool, whose experiences with cast-iron pipe in the original duplicate conduits of the Vyrnwy aqueduct have led him to adopt steel for the third line, which, with connections to the old conduits, is now being constructed piecemeal on low-gradient sections to meet the slowly increasing consumption. When No. 3 is completed, No. 4 will be started.

For the present construction on the No. 3 line, steel with spun-in bituminous lining is being used. This lining is preferred to cement mortar, as the water attacks the latter so that it loses its smooth surface, which suggests still further deterioration. Bell-and-spigot joints are used for the steel pipe. The joints are calked with yarn and with lead in rod form. To protect the inner coating from damage by men and boys passing through it, both ends of the pipe are closed with bulkheads of wood, rodded together. These are not removed until just before the pipe is lowered into the trench. As a further protection while the pipe is being jointed, felt is laid in the bottom of the pipe and the workmen wear rubber boots. When steel pipe is lined by dipping, Mr. Davidson states, the coating comes off in flakes as large as two hands. Spun cast-iron pipe up to 15-in. size has been used in the Liverpool distribution system, but apparently to no great extent.

Whalebone Pipe-Cleaning Brushes—Cleaning the upper 13 miles of the Vyrnwy conduits, above the filtration plant, is necessary from time to time to remove incrustation caused by "water bacteria." Whalebone brushes, shown in the accompanying illustrations, are used. Mr. Davidson describes the brushes as follows:

The brush moves in the direction indicated by the skids on the leading element, being propelled by pressure of the water behind, the flow of the water being regulated by opening sluice outlets on the main in front of the brush.

The three elements vary in diameter and strength of the whalebone bristles. The details are as follows:

	Leading Brush	Middle Brush	Trailing Brush
Diameter of wooden drum, in.	36¼	37	37½
Width of wooden drum, in.	9	9	9
Whalebone bristles square section, in.	⅛	3/16	3/16
Outside diameter over bristles, in.	42½	42½	42½
Weight of whalebone, lb.	23	28	33

The articulation in the shaft of the brush allows a movement of 15 deg. of the leading and trailing brush elements. The paddle, which is mounted on the central shaft between the leading and the middle brushes, revolves on a brass liner and is fitted with a ball thrust bearing. This paddle actuates a clapper which locates the brush when in operation.

The total weight of the brush is 1,261 lb. The length, with rubber buffer in front and rear eyebolt, is 5¾ ft. The rubber buffer is not in position in the photograph.

Birmingham—The cast-iron parts of the two lines of 42-in. diameter pipe in the Elan aqueduct of the Birmingham water-works have given much trouble both from breaks and incrustation. This has led to putting in large supplementary steel pipe at some of the siphons, lined with spun-in cement mortar, lightly reinforced—apparently an early if not the earliest use of spun-in cement mortar lining for steel pipe. This was done while F. W. Macaulay was water engineer of Birmingham. He resigned in the early summer of 1929 and was succeeded by J. W. Wilkinson, until then chief assistant to Mr. Macaulay. I missed seeing either of these men, but in a paper read before the Institution of Water Engineers last May, Mr. Wilkinson said:

In rocky ground the trenches for the Elan aqueduct were excavated to an extra depth of 6 to 9 in. below the barrel of the pipe and the space was filled in with any material available. After the pipe was put into use failures during hot summer weather were frequent, sometimes throwing both mains out of use. The breaks were worst at the end of dry summers. This was attributed to deep ground cracks, generally parallel to the original sides of the trenches, which caused shifts in the earth covering and breaks in the pipe. It is thought that groundwater collected in this soft material and washed it out. In 1909 the following remedial measures were adopted and have since been continued. The soft material was removed to a depth of 4 to 6 in. for a length of 8 ft. for each pair of pipes and a cradle of concrete put in. The cast-iron pipe thus bedded has given no trouble from breaks.

More capacity being necessary, estimates for a third line put the cost at £700,000, or about $3,400,000. The World War prevented construction. After it was over prices were three times what they had been before. In-

stead of laying a third line the entire length of the aqueduct it was decided to put in stretches of large pipe at strategic points and connect them with the two old lines. Steel pipe of 60-in. diameter was adopted. In view of the incrustation of the existing cast-iron and steel pipe, reinforced-concrete pipe was considered advisable and two sections or stretches of the Severn siphon were built of that material (Bonna type). Then for a third section use was made of $\frac{3}{8}$-in. steel plates, welded into plain 62-in. cylinders 12 ft. long, lined with 1 in. of centrifugally applied 1:2 cement mortar, lightly reinforced. The joints were formed into steel collars 5 in. wide with lead run in. After jointing, the exterior of the pipe was surrounded by "8:1 concrete of a rather fine mixture."

Later 62-in. steel pipe of the same general kind was used, but in 15-ft. instead of 12-ft. lengths and with sockets instead of collars at the joints. The inside gap of about 1 in. between pipe lengths was pointed up to give a continuous inner concrete surface. Still later "several succeeding lengths of 60-in. mains have been put in hand on four of the aqueduct siphons." Reinforcement of the cement mortar lining has not been used on these lines, but specials continue to be reinforced, the lining being put in by hand.

Apparently, the cement-lined steel pipes were first considered in 1919 and put in then or soon afterward; perhaps in 1921, when Mr. Macaulay induced the Stanton Iron Works, which had bought the Hume patents on spun reinforced-concrete pipe, to spin cement-mortar lining into some steel pipe supplied by him.

The inside of both the cast-iron and the steel pipe in the original Elan aqueduct is hand-scraped from time to time, to remove incrustation. Mr. Wilkinson in his paper questioned whether this is worth while, since the flow has to be shut off while the line is being cleaned, just about offsetting the gain in carrying capacity caused by the cleaning.

Salisbury—In the Salisbury water-distribution system cast-iron pipe, with leaded bell-and-spigot joints, is used. Charles Notley, deputy city engineer and surveyor and since youth in the city engineer's office, remembers only one break—in a 9-in. pipe laid about 1850. It was repaired by "semicircular fishplates" (a split sleeve) with packing beneath. No spun cast-iron pipe has been used at Salisbury. For house connections lead is used exclusively. Meters are not used on domestic services.

Southampton—At Southampton about 30,000 ft. of 15-in. steel pipe is now being laid, I was told by A. P. Fisher, first assistant to E. C. Rodda, water engineer. The pipe is $\frac{5}{8}$ in. thick, hammer-welded longitudinally, with leaded hub-and-socket joints. It is dipped in hot bitumen and wrapped with three courses of Hessian, also dipped in the same material. As this line of pipe parallels one of cast iron, it is not expected that it will be tapped for house connections, but Mr. Fisher sees no bar against tapping. Cast-iron pipe of the de Lavaud type up to 15 in. has given satisfaction. A Belgian make of spun pipe is about to be put down.

The water-works system includes about 600 miles of pipe in an area having a 15-mile radius landward, but much of this lies outside the borough, having been taken over recently from a private water company. The range of size is 3 in. to 36 in., with some 2-in. pipe in the part of the works taken over. The many short streets supplied, Mr. Fisher said, account for the continued use of 3-in. mains. All cast-iron pipe has Dr. Angus Smith or coal-tar coating.

Breaks in cast-iron mains have been more frequent of late than formerly, due to the great increase in weight of motor vehicles, which cause marked earth vibration.

House connections are of lead. (The water supply is drawn from wells in the chalk, softened but not otherwise treated.) The water department taps the main. The consumer lays the service. After he has maintained it for a year it is taken over by the borough, from the main to the corporation stopcock, which is in the middle of the sidewalk. Meters are used on trade supplies and on domestic supplies where hose is used for car washing and garden or lawn sprinkling.

Glasgow—In cast-iron mains having turned-and-bored joints, breaks occur. These are caused by wide variations in the winter and summer temperatures of the Loch Katrine water.

It may not be out of place to note the use at Glasgow, more than a century ago, of ball-and-socket joints on submerged water pipe, said to be the first instance of the kind. According to a recent book, James Watt, on being consulted, in 1811, on "carrying water from the filtering area to the pumping engines on the south side of the Clyde," proposed cast-iron pipe with ball-and-socket joints, "which he then first introduced" with success. It is said that a wooden model of the joint was (subsequently?) sent to the Institution of Civil Engineers. (See "James Watt and the Steam Engine," by J. W. Dickinson and Rhys Jenkins, reviewed in Engineering Literature Section, *Engineering News-Record*, Nov. 15, 1928, p. 741.)

Economic Survey of Reclamation Is Planned

PREPARATIONS for a survey of the economic features of reclamation are now being made by officials of the U. S. Bureau of Reclamation, who will be aided by Alvin Johnson, assistant editor, Encyclopedia of Social Science, New York; Prof. Frank Adams, of the University of California, and one other yet to be named. Advice will also be received from Anson Marston, dean of the school of engineering, Iowa State University; Charles L. Lory, president, Colorado Agricultural College, and J. W. Haw, director of agricultural developments, Northern Pacific Railway.

The study is to be made to make more definite the economic principles and policies which should govern the undertaking and development of reclamation projects.

In each of the projects investigated information will be assembled as to the history of the project, with particular attention to its financing; present economic and agricultural conditions; the status of the present landholders; the demand for land; the amount of individual capital required to develop a new farm in the project; and available sources of credit and markets, including transportation facilities. Recommendations will be made for the improvement of conditions existing in present projects largely undeveloped and unirrigated after several years of operation, projects now being constructed in which the cost of water is expected to be so high as to raise a question of the ability of settlers to meet payments, and private projects which desire government aid.

Steel Used for Large Water Mains in New York City

For 30-In. and Up Coated Pipe From ½-In. Plates Used—Type of Longitudinal Joints Optional Without Differentials

By William W. Brush

Chief Engineer of Water Supply, Department of Water Supply, Gas and Electricity, City of New York

A GENERATION ago the use of cast-iron pipe for water mains was almost universal. Since then pipe fabricated of other materials have entered into active competition with cast-iron pipe and a statement of present-day practice in New York City is of interest. Since cast iron still holds the field without serious competition in diameters up to about 30 in., this article will be limited to pipe of that size and larger.

Materials Used—For pipe 30 in. and more in diameter steel plate ½ in. thick has been used generally during the past five years, with one line of 36-in. reinforced-concrete pipe and occasionally a cast-iron line. The largest steel pipe thus far laid by the Department of Water Supply is 60 in., but the Board of Water Supply has laid steel pipe up to 72 in. (The board constructed the Catskill aqueduct and accessories and turned it over to the department for operation.)

Abandonment of Cast Iron—Breaks in large cast-iron mains in New York are almost always caused by external loading and foundation conditions (Fig. 1). Settlement may take place, the pipe may rest on an unyielding small area, such as a boulder, point of rock, sewer, timber or another pipe. Above the pipe may be a duct bank, surface street-car yoke, a large gas main or similar structure, thus concentrating an abnormal load on the water main and raising the stress beyond the strength of the metal.

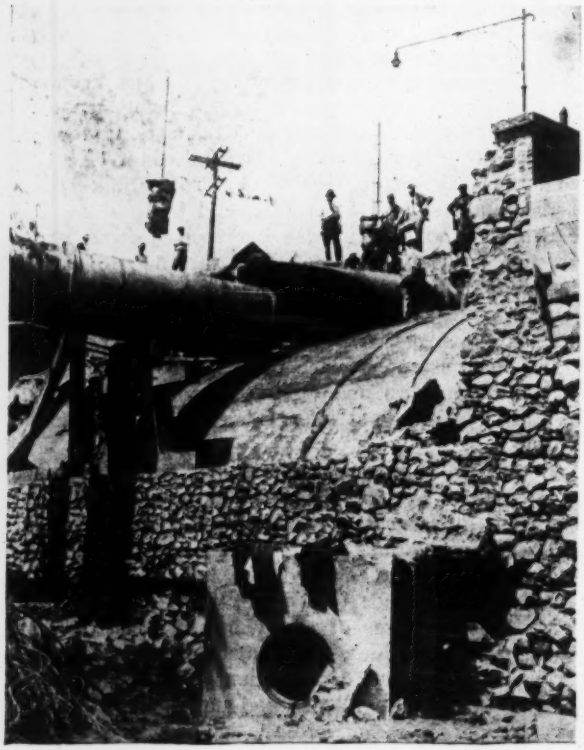


FIG. 1—BREAK IN 48-IN. CAST-IRON PIPE AT CROSSING OVER RAILROAD CULVERT
Section of pipe broken out is typical of breaks in large mains.

FIG. 2—LAYING 66-IN. RIVETED STEEL PIPE IN BOROUGH OF RICHMOND
Since it was laid, this pipe has been seriously damaged by electrolysis.

When a crack starts in a cast-iron water main it is generally in the bell, and the water pressure extends the crack until a large section is actually torn off. The fracture where the broken piece is finally separated from the pipe is approximately at an angle of 45 deg. to the plane of the pipe surface instead of 90 deg., as in the case of the crack itself. With an opening frequently equal to or greater than the area of the pipe, the escaping water heaves the pavement, fills the streets and basements and at times stops subway operations. The resulting damage may be well over a half-million dollars. With a more elastic material such as steel the failure would occur by tearing the plate or shearing the rivets at the circumferential joint and only a moderate amount of water would escape from the pipe. The use of large sizes of cast-iron pipe has therefore been abandoned except where a line is to be laid through a park where the foundation is not likely to be disturbed in the future and a break would not do much damage or where a line is needed in a hurry and cast iron can be furnished and installed more quickly than steel.

Minimum Diameter of 30 In.—A pipe diameter of 30 in. is the least that can be reasonably cleaned and recoated in place. Until a coating has been developed and proved by many years' experience to protect iron from the corrosive action of active waters, such as are found along our Atlantic seaboard, the writer believes

that steel mains should be cleaned and recoated in place every 15 to 25 years and that if this procedure is followed, the life of a steel main made of ¼-in. plate and laid in soil such as is found in New York should be more than 100 years, if not destroyed by electrolysis.

As to dangers from electrolysis it may be noted that a 66-in. steel main laid by the Board of Water Supply in the Borough of Richmond in 1925 (Fig. 2) was so badly pitted by electrolysis due to a local electrical condition that last year 25,040 pits had to be filled in by welding in a stretch of 723 ft., at a total cost of $14,304. In the Borough of Queens, pitting by electrolysis has been recently found on a 72-in. steel pipe laid by the Board of Water Supply in 1927. An electrical survey in this borough shows that action will have to be taken either to change the electrical conditions in the soil or through bonding or insertion in the pipe line of insulation joints to prevent a current flowing through the pipe in such a manner as to cause pitting by electrolysis.

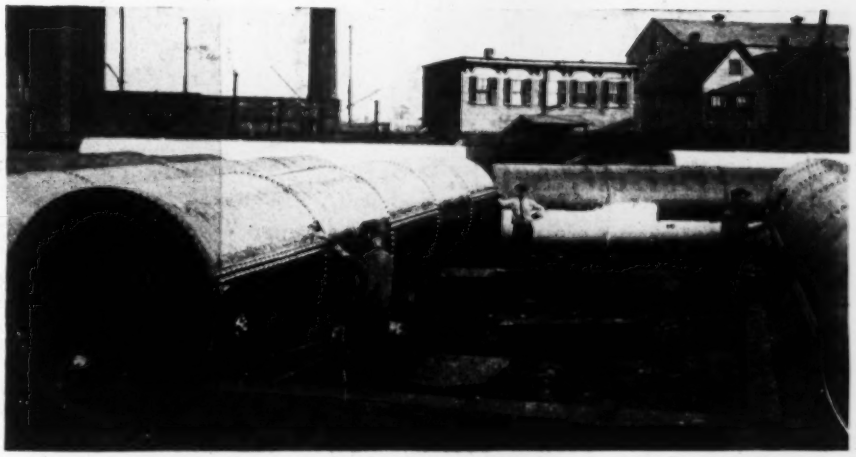


FIG. 3—HAND APPLICATION OF BITUMASTIC ENAMEL COATING
Whitewash to minimize heat absorption of pipe after coating is being applied at left top of pipe, and has been applied at bottom of the pipe length in center. This work was done for the Board of Water Supply.

Thickness of ¼ In. for All Sizes—The thickness of a steel pipe which is expected to remain in service indefinitely should be based on the amount of metal necessary to withstand corrosion and to give stiffness and mechanical strength to meet city street subsurface conditions. The thicker the metal the longer the life and the fewer breaks during that life. The added thickness of metal does not add proportionately to the final cost of the pipe as installed. One-half inch plate is the maximum thickness that can readily be fabricated by the various pipe processes now used and be easily joined in the field, so this plate thickness was adopted.

Types of Longitudinal Joints in Steel Pipe—The contractor who is called upon to furnish and install the pipe complete is given the choice of lock-bar, riveted, hammer lap-welded or gas-welded or electrically welded longitudinal joints. The hammer lap-welded cannot compete on a price basis, but in the last three years contractors have furnished lock-bar, riveted and electrically welded joints, the latter being the one usually offered. This joint, under the department specifications, must show virtually 100 per cent of the plate strength, break outside of the weld on tensile tests made on coupons cut from the finished pipe, and bend cold 180 deg. around a 2¼-in. pin without sign of fracture.

Variation in Diameter Due to Type of Joint or Material—No allowance is made due to an assumed variation in the carrying capacity of a pipe line on account of the type of longitudinal joint or materials used. If a 36-in. pipe is determined to be the proper size, this diameter must be furnished even when reinforced-concrete pipe is included in the specifications. The tuberculation of steel pipe will have more effect on the capacity than will the type of joints. No one can determine with certainty the actual capacity coefficient of a given pipe line when new or after twenty years. In New York alternative bids cannot be taken and compared, as the corporation counsel holds that under alternative bids any one will serve the required purpose and so the lowest bid must be accepted. Under New York conditions it is believed to be proper policy to make no allowance in diameter for assumed differences in capacity.

Circumferential Joints—Single-riveted joints are used, but consideration is being given to a yoke joint, and electrolysis may cause a change in the present riveted joint, which is not considered altogether satisfactory, as it gives only about 56 per cent of the strength of the plate at the part of the pipe line which is most likely to break if settlement takes place.

Coating—A hot dip or a hot bitumastic hand-applied enamel may be used, at the option of the contractor who chooses the hot dip as the cheaper. The mill scale is removed by sand or shot blasting or by pickling and then the coating is applied, with a minimum specified thickness of $\frac{1}{8}$ in. Experience with pipe lines twenty years or less in age indicates that the dip coating will last about fifteen years before it should be renewed. Fig. 3 shows steel pipe being hand coated with enamel, under a Board of Water Supply contract.

Conclusion—It is evident that present New York City practice does not give such results as to justify stating what will be standard hereafter. The field is an open one in which many are experimenting and our practice is likely to change rather rapidly in the future.

Street Improvements in Sao Paulo

Paving and widening streets in Sao Paulo, Brazil, has been progressing rapidly in the last two years. In 1926 a contract was made for the paving of 3,000,000 square meters of city streets at cost plus 10 per cent, the total expenditure not to exceed $9,720,000. However, the city is growing fast and the prefect, who is an engineer, advocates the paving of a minimum of 500,000 square meters annually during the next ten years. The municipality pays one-third of the cost. San Joao Ave., formerly a narrow street, is being gradually converted into an avenue 30 meters wide. The work has been going on since 1911; all the right-of-way has been acquired and the project is about two-thirds completed. Anhangabahu Ave. has been laid out as a radiation avenue 30 meters wide through largely undeveloped territory. Much of the right-of-way has been acquired and grading is proceeding rapidly.

Water-Pipe Practice at Detroit, Mich.

Steel and Pure Iron for Sizes Above 36 In.—Cast-Iron Pipe Bought on Favorable Market and Stored in Well-Equipped Yards

By George H. Fenkell
General Manager, Department of Water Supply Detroit, Mich.

AMPLE STORAGE CAPACITY IN WESTERN PIPE YARD, IN DETROIT
Six-inch pipe is piled two dozen layers high by a traveling crane.

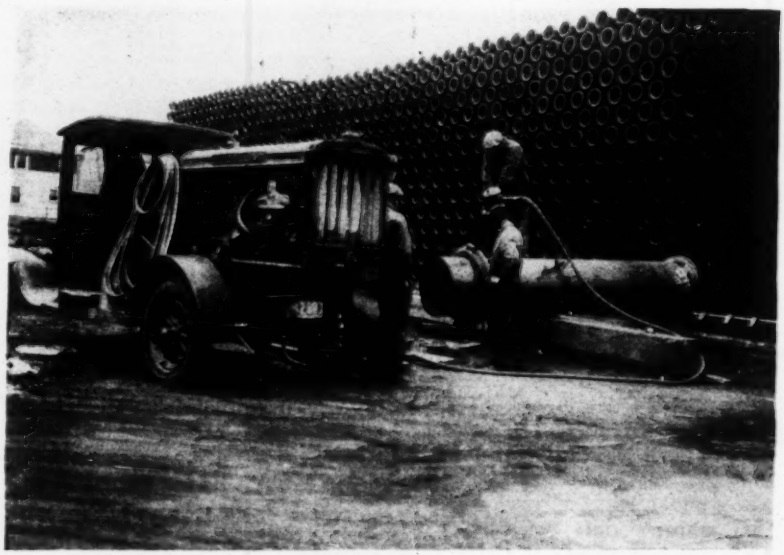
DURING the last few years the Department of Water Supply, Detroit, Mich., has used steel pipe almost exclusively in sizes larger than 36 in. The principal reasons for using steel pipe are its favorable first cost and the fact that steel pipe is not subject to sudden breaks which would occasion serious interruption to service and cause great damage to streets and adjacent property. The minimum thickness of plate used is ½ in. Both lock-bar and welded longitudinal joints have been used. Installation has been done generally by contract, the contractor furnishing the pipe. This method has been followed because the department's forces are not well adapted for laying steel pipe. Concrete pipe has not been used.

In recent contract proposals for furnishing and laying steel pipe, bids have also been invited on pipe made of pure iron or pure iron plus a small percentage of copper. The bids have been evaluated for comparison on the basis of ten years' longer life for the pipes made of pure iron or pure iron and copper than for steel pipe. The assumption is made that the work will be paid for by issuing 30-year 4 per cent bonds. Each type of material is credited with that proportion of first cost represented by the assumed useful life of the pipe line after it has been paid for by retirement of the bonds. At present, for the purpose of evaluation, a life of 35 years is assumed for steel pipe and 45 years for the other types mentioned.

The department maintains a large force of employees for construction purposes and has sufficient equipment to lay all sizes of cast-iron pipe. Four storage yards are in operation, and the site for another yard has been secured. Large areas for storing pipe are therefore available. The endeavor is made to buy pipe on a low market and in quantities that will be sufficient to supply the demand of the department for at least six months.

Within the past year three large contracts for furnishing and laying large water mains have been awarded. These mains are a part of the general plan of distribution for both the present and the new supplies. The contracts included a little more than 9 miles of 48-, 54-, 60- and 72-in. pipe. The last contract awarded was for pure iron instead of steel plates. The total estimated cost of the three contracts was $1,073,193.50.

The water supply for Detroit is taken from the upper regions of the Detroit River, has a hardness of about 100 parts per million, and is quite non-corrosive. Generally the soil through which the pipe lines that supply water to the city are laid is clay which is not of a corrosive nature.



PIPE CUTTER FOR LARGE SIZE WATER PIPE OPERATED BY AIR MOTOR
Air supplied by a portable compressor. The motor was rigged up for field use from a stock drilling outfit.

Experiences in Cleaning Seven Miles of 16-In. Cast-Iron Water Main

Some Observations on Good Practice and a Discussion of the Relation Between Roughness Coefficients and Nodulation

By Arthur T. Clark
Chief Engineer, Supervising Engineers, Inc.
New York City

Supervising Engineers, Inc., of which the author of this article is chief engineer, is an organization formed to operate the subsidiary companies of the Community Water Service Company. —Editor.

During the past twenty years equipment for the efficient cleaning of cast-iron water mains has been under development and test, and today it is possible to clean practically any size main and restore its original carrying capacity. This operation, like most others, has its disadvantages as well as its advantages, and the following observations relating to recent experiences in cleaning more than 7 miles of 16-in. cast-iron pipe are made in an endeavor to minimize the one and to improve the other. There will be given some of the data on the nodulation and roughness coefficients noted on this line, after which some observations of general applicability to pipe-line cleaning will be presented.

The pipe line under consideration is a 38,000-ft. force main located between a pumping station in Pocantico Hills, near North Tarrytown, and Dobbs Ferry, N. Y. The upper third of this main was laid about 1885 and the remainder in 1906. The main had been cleaned in 1925, but no records of its condition before or after cleaning were available. In the fall of 1928 it was found that the flow had again decreased to approximately 2,000,000 gal. per day (2 m.g.d.) under an increased pumping head which was dangerously close to the allowable limit. At the same time the pressure at the lower end of the main was reduced to the minimum necessary to maintain a flow-line level in the distribution reservoir.

Observations of pressures at various points on the line indicated such an irregular hydraulic gradient that check levels were run over the entire 7 miles to determine accurately the elevation of the gaging points. The gages used were also carefully checked. With corrected elevations and calibrated gages, it was found that a maximum of 2.1 m.g.d. could be transmitted with a loss of head of 5.38 ft. per thousand, indicating a value for the coefficient C in the Williams and Hazen formula of 59.5. The profile of the pipe line and the hydraulic gradient under these conditions are shown in Fig. 1.

The original 16-in. main extended only to a point between Weber Ave. and North Tarrytown, at which point it reduced to 12 in. In 1906, when the 16-in. main was extended through to Dobbs Ferry, it was connected to the original line, as shown at the left in Fig. 2. The effect of this connection is indicated in the hydraulic grade line at both Weber Ave. and North Tarrytown (Fig. 1). In cleaning the main with this construction it

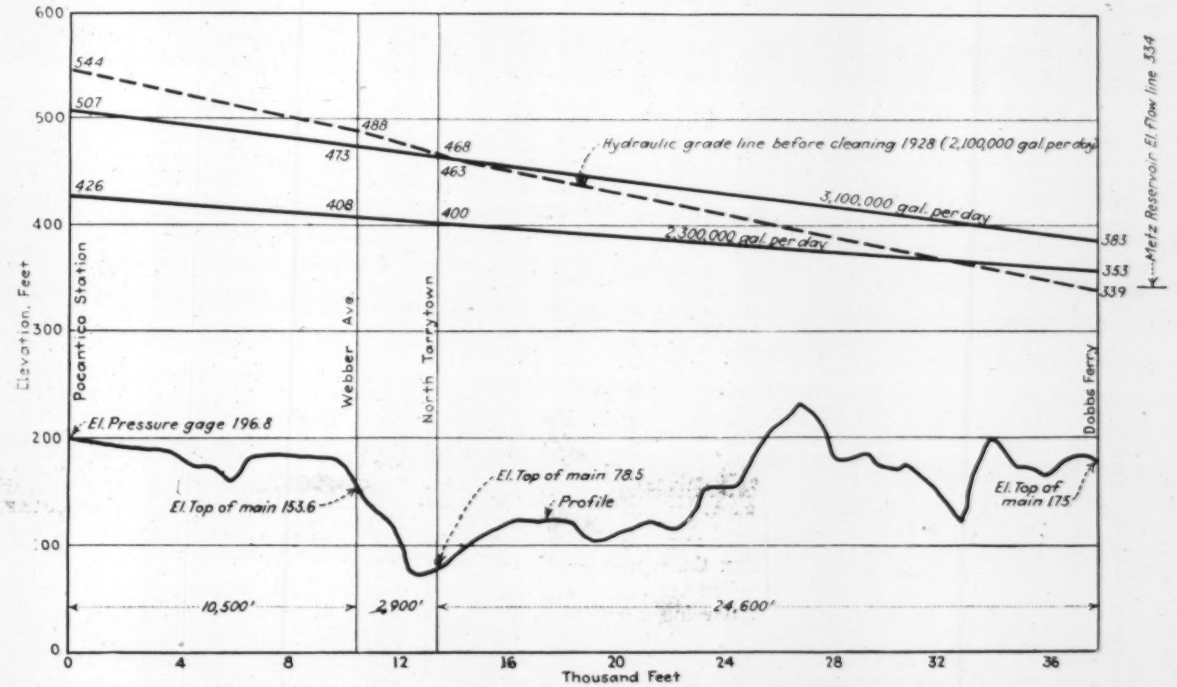


FIG. 1—PROFILE AND HYDRAULIC GRADE LINE OF 16-IN. CAST-IRON MAIN

would have been necessary to cut the 16-in. pipe both above and below the bull tee, and accordingly it was decided to eliminate this tee by reconstructing the line at this point, as shown at the right in Fig. 2.

Two test flows were run after the cleaning, at the respective rates of 2.305 and 3.1 m.g.d. The slopes of the hydraulic gradient and the equivalent values of *C* are given in the accompanying table. The slopes are also shown in Fig. 1. (The 12- and 10-in. line paralleling the 16-in. line from North Tarrytown to Dobbs Ferry was closed during all of these tests.) It will be noted that the coefficient was increased from 59.5 before cleaning to an average of 115.9 after cleaning. At the same

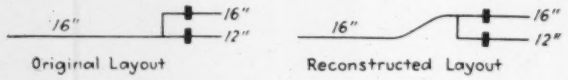


FIG. 2—METHOD OF CHANGING A TEE CONNECTION TO PERMIT PASSAGE OF THE CLEANING MACHINE

time the flow was increased from the previous maximum of 2.1 to 3.1 m.g.d. with a reduction in initial head of 40 lb. and an increase in residual pressure of 45 lb. If, after cleaning, the pressures at the Pocantico pumping station and at Dobbs Ferry had been brought to the same values as existed prior to cleaning—that is, by duplicating the slope of the hydraulic gradient—a flow of 4 m.g.d. would be obtained from the tables, indicating that the capacity of the main was increased almost 100 per cent by the cleaning.

The loss of head per thousand feet was reduced from 5.38 to 1.87 for a flow of 2.1 m.g.d. From the figures available it is impossible to determine the exact loss of head caused by the two tees in the original line at North

RESULTS FROM TWO TEST RUNS AFTER CLEANING

Flow of 2.305 m.g.d.

Stations From	To	Slope in Ft. Per 1,000 Ft.	Williams & Hazen *C*
Pocantico plant	Weber Ave.	1.87	115.8
Weber Ave.	Tarrytown	1.90	114.6
Tarrytown	Dobbs Ferry	1.86	115.9
Overall Pocantico plant	Dobbs Ferry	1.87	115.8

Flow of 3.1 m.g.d.

From	To	Slope in Ft. Per 1,000 Ft.	Williams & Hazen *C*
Pocantico plant	Weber Ave.	3.21	116.0
Weber Ave.	Tarrytown	3.30	114.2
Tarrytown	Dobbs Ferry	3.18	116.4
Overall Pocantico plant	Dobbs Ferry	3.21	116.0

Tarrytown. However, from the meager information available, it would appear that the decrease in the friction losses at this point warranted the relocation of these fittings.

Nodulation and Roughness—The principal shortcoming in cleaning a water main is that the conditions which cause the original nodulation are not corrected or eliminated. Indeed, there seems to be a tendency for the cleaning operation to leave the interior of the main in such a condition that a more rapid rate of growth of the nodules may develop after cleaning than before. With this possibility in mind, periodic tests are being made. The first was completed approximately five months after the cleaning and indicates a slope of the hydraulic gradient of 4.65 ft. per thousand and a value for *C* of 92.

Experience on this pipe line indicates that the nature of the nodulation for a given water will often vary between the first growth and that which may develop after cleaning. The first growth may consist of small semi-spherical growths originating from a point of exposed iron. Nodulation developing after cleaning is more apt to occur in fewer although possibly more pronounced growths. The contour and spacing of the nodules in the 16-in. main prior to cleaning are shown in Fig. 3. Fig. 4 also shows the condition existing in the main.

In general, the nodules vary between $\frac{1}{8}$ and $\frac{3}{8}$ in. in height, between $\frac{1}{4}$ and $\frac{1}{2}$ in. in width at the base and are about $\frac{3}{4}$ to $1\frac{1}{4}$ in. long. There were numerous small nodules, almost circular in form, about $\frac{1}{8}$ in. in diameter and $\frac{1}{8}$ in. high. There was, however, no general deposit or growth covering the entire surface of the pipe nor was there any nodulation of the flattened-out mushroom type. The nodules were spaced on an average about $1\frac{1}{2}$ in. center to center crosswise of the main and about $\frac{3}{4}$ in. center to center in the line of flow. The upstream face of all nodules was quite steep, about 60 deg.; this face was smooth and slightly rounding at the top. The downstream face flattened out to about a 30 deg. angle and the surface rippled parallel with the base, or lengthwise of the nodule. No sand could be detected in the material removed from the main during the cleaning, although the pumps that supply this line take water direct from a battery of pressure filters.

Analyses of the raw and treated water from Pocantico

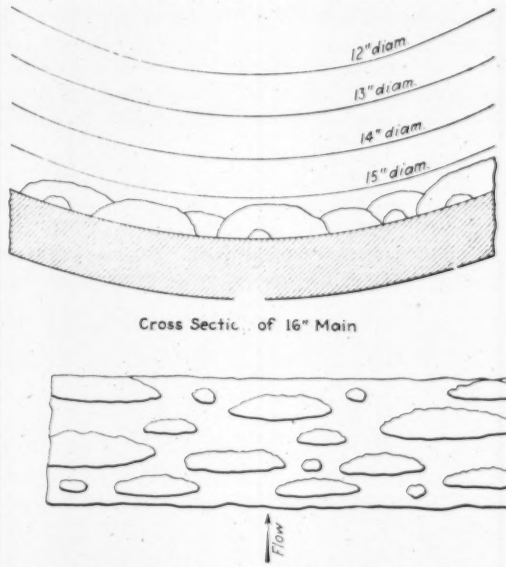


FIG. 3—SKETCH OF NODULATION IN PIPE LINE

Lake are given in the accompanying table and some special tests at the plant and from a tap at the Dobbs Ferry end of this transmission line show the following results:

	Plant Effluent (1)	Plant Effluent (2)	Dobbs Ferry (1a)	Dobbs Ferry (2a)
pH	8.60	8.50	8.20	8.50
Fe, parts per million	0.10	0.02	0.32	0.06
Dissolved O_2, p.p.m.	9.05	10.0	8.70	9.7
Per cent saturated	72.0	85.0	66.0	82.0

No. 1 and No. 1*a* were taken immediately after cleaning in January, 1929; No. 2 and No. 2*a* were taken in April, 1929.

ANALYSES OF RAW AND TREATED WATER FROM POCANTICO LAKE

	Turbidity, P.P.M.	Alkalinity, P.P.M.	pH	Color, P.P.M.	Lime, Lb. Per Million Gal.	CO_2 P.P.M.	Total Hardness, P.P.M.
Raw Water, Average							
Dec., 1928	2	42	7.2	27	157	1.2	65
April, 1929	6	23	6.6	19	160	6.3	42
Filter Plant Effluent, Average							
Dec., 1928	0	48	8.1	7	...	0	77
March, 1929	1	29	8.6	9	...	0	60

So far the data show less iron being dissolved during the passage of the water through the main and that less oxygen is being used up. As a result, nodulation and corrosion should be at a rate smaller than before. These or similar tests purporting to indicate the corrosive tendencies of the water have not extended over a sufficient period of time as yet to form the basis of any conclusion as to a high pH value solving the problem.

An analysis of the nodules as removed from the main showed the following with no indication of organic matter:

	Per Cent		Per Cent
Moisture	1.59	Sulphate	0
Matter insoluble in boiling hydrochloric acid	0.95	Calcium oxide	1.37
Oxide of iron and aluminum	74.05	Loss on ignition	11.03
Magnesium	0	Undetermined	11.01

The comparatively uniform spacing and form of the nodules (Fig. 3) are no doubt the result of the previous cleaning, the nodulation occurring where the blades of the cleaning machine bit into the coating and exposed the raw iron surface.

It is interesting to note in this connection that for the same slope and the same rate of flow a 12-in. water main with a coefficient *C* of 100 would have fulfilled the hydraulic conditions found in this 16-in. main before cleaning. This may or may not indicate that nodulation, under certain rates of flow, might be considered to reduce the available effective or working area of a pipe to five times the height of the nodule. Additional information regarding the correlation of surface roughness with coefficients of roughness is much to be desired. This does not mean that a special formula or a separate set of coefficients is to be applied to various pipe materials, such as iron, concrete, wood, etc., but would indicate rather that the correlation should be between some adopted formula and the "measure of the roughness" of the surface.

Operating the Cleaning Machine—After the pipe had been closed and blow-offs along the line opened, water at 90 lb. pressure from a storage reservoir near the pumping station was applied back of the cleaning machine. This pressure proved insufficient and it became necessary to shut off the reservoir and pump directly to the line, maintaining a pressure of approximately 110 lb. This increase in pressure was probably necessary because the cleaning blades were set up tight to the wall of the pipe to insure maximum cleaning.

The machine required approximately five hours to travel 38,000 ft. (126 ft. per minute), and approximately 1,000,000 gal. of water (some 25,000 gal. per 1,000 ft. of main) was used in the actual cleaning operation. This included the water necessary to force the machine through the main, a liberal flushing at each of the blow-offs and the refilling of the main.

General Observations—Extreme care should be taken in determining the exact gage elevations and in observing the pressures, because a very small error in elevation produces an unlooked for variation in the value of *C*.

Where several observation stations are established, simultaneous readings should be taken at regular intervals and all watches should be compared before and after the test.

Calibrations of all gages at 5- or 10-lb. intervals, by a dead-weight tester or by comparison with standard test gage, should be made immediately before the test. Test gages should be handled and transported with extreme care preceding and during the test.

It would be well to provide suitable arrangements for the installation and the removal of the cleaning machine at both ends of the main. This may be done through the insertion in the main of sections of pipe of the proper length connected into the line by Victaulic joints such as are used on some oil and gas mains; this joint will permit the pipe to be lifted from the line so that the machine can be inserted or removed.

In cleaning a long main the expenditure of considerable money may be avoided and much mental grief may be spared by providing sufficient help to keep track of the machine as it passes through the main.

All branch connections should be closed to avoid clogging services and connections with an accumulation of

FIG. 4—APPEARANCE OF NODULES IN 16-IN. MAIN BEFORE CLEANING

sediment. A force pump should also be available so that any obstruction to a service between the main and the curb stop may be readily removed from the house at the service pipe as soon as the main is replaced in service.

To avoid "stopped" meters on services fed from the main being cleaned, all such meters should be removed or disconnected by the meter department and not replaced until after the services have been well flushed.

If an accurate type of meter is not available in the main, one or more pitometer stations should be established and the flow before, during and after cleaning should be carefully recorded. Several makes of instruments are available for this use and the results obtained will more than repay the cost of such a survey.

If the determination of the coefficient *C* varies by any considerable amount for the various sections of the pipe line under observation and there is no known physical reason for the variation due to fittings, etc., the elevations of the gages should be carefully checked before placing too much reliance on the results. The gages themselves should also be tested.

Acknowledgment—The work referred to above was done by the National Water Main Cleaning Company under the supervision of H. A. Helling, resident manager, Pocantico division, the New Rochelle Water Company, Dobbs Ferry, N. Y. Chemical analyses of water and nodules were furnished by M. E. Flentje, superintendent of purification, Supervising Engineers, Inc.

Akron Develops an Airport for Planes and Dirigibles

Freedom From Air Currents, Fogs and Flooding Factors in Selection of 890-Acre Site

THE problems incident to developing a satisfactory air terminal at Akron, Ohio, are somewhat special, inasmuch as the needs of a large dirigible construction program must be met in addition to the more usual necessity of providing an adequate port for heavier-than-air machines. An 890-acre tract, situated about 4 miles from the center of the city, has been selected and is now undergoing intensive development. Not only is the city carrying out its program of grading and sewerage and water-supply construction but the Goodyear-Zeppelin Corporation is constructing a large factory and dock at the airport.

Preliminary Plans—An important element in the preliminary planning was the fact that an airport committee of the Chamber of Commerce secured options on the land before land speculators could learn of the location chosen for the airport. Then, since the proceeds of a city bond issue would not immediately be available, an advance of funds necessary to take over the land was secured from the Akron Industrial Foundation.

Choice of Site—For a number of years various sites within a radius of 10 miles of the city had been under consideration. Akron is located on the divide between the Cuyahoga and Tuscarawas rivers and the surrounding topography is quite hilly, hence the task of finding a suitable site was not an easy one. However, the site finally selected is directly on top of the divide, where

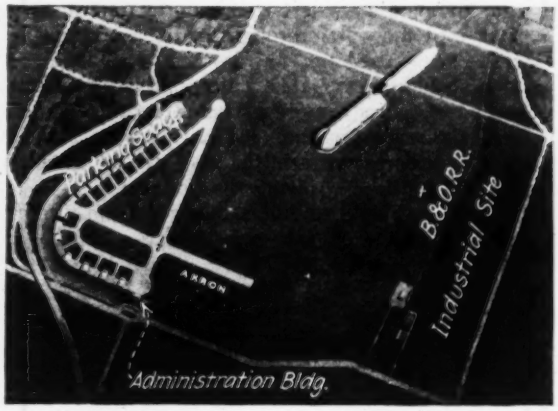


FIG. 1—PLAN FOR DEVELOPMENT OF AKRON MUNICIPAL AIRPORT

all possibility of flooding is eliminated and where fogs are infrequent and of short duration. At the same time the airport is sheltered on two sides by low hills. The airport is at an altitude of 1,040 ft. above sea level. The direction of the prevailing wind is from the southwest and in this direction the horizon is very low and away from the built-up section of the city. The site is substantially rectangular, 1¼ miles long on each side. Four arterial highways lead from the city to the airport. It is also served by bus lines and an electric railway, and the Baltimore & Ohio Railroad runs through one side of the tract.

Plans for Development—The airport when fully developed will provide 2,500-ft. runways in eight directions and one 5,000-ft. runway in the direction of the prevailing wind. As shown in Fig. 1, which shows only

FIG. 2—AKRON MUNICIPAL AIRPORT
Airship dock erection half completed. Grading operations in left background. Planes may be seen on temporary field beyond and to right of dock.

the preliminary layout so far as runways are concerned, the hangars are placed in one corner of the field with the larger hangars next to the administration building and the smaller hangars farther away toward the south.

An area ¾ mile long and ½ mile wide will be used for the lighter-than-air ships. In this area the Goodyear-Zeppelin Corporation is now building its factory and dock, a steel arch truss structure 1,200 ft. long, 325 ft. wide and 200 ft. high. This dock was described in *Engineering News-Record*, April 11, 1929, p. 583.

A part of the airport, which is partly level, is now being used for a temporary landing field. This area is 2,000 ft. long and is lighted with the necessary boundary, obstruction, flood and beacon lights and provides facilities for the air-mail and passenger planes now using the airport.

The entire surface of the field, after the grading has been completed, will be sowed with grass seed. The type of grass has not yet been determined but will be worked out with the Ohio Agricultural Experimental Station after tests have been made on small plots of the soil. The type of grass selected will be chosen because it is best adapted to holding a tough turf.

The runways will be progressively surfaced either by bituminous mulching of the soil or by a bituminous treatment similar to traffic-bound highway construction. When the settlement of the earth is complete and a substantial foundation is built, the runways will be surfaced with concrete, brick or asphalt.

Work Accomplished—Since the beginning of the development about a year ago, water service has been extended to the airport, a large storm sewer has been constructed to form the main outlet for surface and underground drainage, a contract has been let and partly completed for moving 1,000,000 cu.yd. of earth and for grading the surface of the airport, the entire area has been cleared of trees and houses and the plans are complete for the construction of a sanitary sewer to serve the buildings to be built.

The character of the soil is sand and gravel mixed with clay. This mixture compacts readily and drains exceptionally well. In grading the airport, tractors in conjunction with crawler wagons and motor trucks have been found to be the most efficient equipment for moving the earth. The hauls average about 1,500 ft. The hauling equipment consisted of fourteen 3½-yd. motor trucks used for all hauls over 1,000 ft. and nine crawler tractors pulling 6- and 8-cu.yd. wagons used on the shorter hauls.

Included in the excavating contract were the stripping and storage of 200,000 cu.yd. of top soil to be later spread and rolled over the entire graded area. The soil in the cuts, being of a sandy nature, was easily excavated. The maximum depth was 35 ft. and the average depth about 7 ft. Fills averaging about 5 ft. in depth were required over a mucky swamp of considerable area. Four gasoline power shovels and a dragline were used for excavating. The dragline was employed in ditching and in stripping and piling the top soil.

Administration—The Akron municipal airport is under the control of an airport commission authorized by the city council. This commission is composed of Fred E. Swineford, director of public service, who is chairman; George F. Zook, president, Akron Municipal University, and Fred M. Harpham, vice-president, Goodyear-Zeppelin Corporation. By placing the control of the airport in the hands of a commission, two members of which remain continually in office, the possibility of abrupt change of personnel due to changes of city officials is removed.

Temperature Variations Cause Trouble on Jerusalem Pipe Line

By A. Palotan

Assistant Engineer of Water Supply, Jerusalem, Palestine

TEMPERATURE variations give rise to difficulties in operating the water-supply pipe lines of the city of Jerusalem. In summer the air temperature often ranges from 15 to 40 deg. C. (59 to 104 F.) within the 24 hours. Where the pipe lines are exposed to the direct rays of the sun, the temperature of the pipe may fall from 55 deg. C. at noon to 15 (131 to 60 deg. F.) or less in the night. Of two experiences under these conditions one was caused by expansion and the other by contraction of 8-in. pipe laid with Victaulic joints.

The first case occurred on a stretch of 400 meters, or 1,300 ft., of exposed pipe where it became necessary to replace a cast-iron socket tee piece by a flanged one. There being no valve on the pipe line for shut-off purposes, disconnection and resulting emptying of the pipe were required. At 11 a.m. on a hot day one of the Victaulic joints was removed and the two abutting pipe ends pushed aside from each other. The new tee was in place by 4 p.m. It was found that the heat had expanded the pipe so that it was ¼ in. too long for making a new joint connection.

Owing to absence of storage it was highly important not to wait until the pipe had contracted after the daily temperature drop. Men were put to work throwing water over the outside of the pipe with buckets and shovels throughout a length of 150 meters (492 ft.). Water was also poured into the pipe from buckets. In some fifteen minutes the pipe had so contracted that the two ends could be pushed into alignment and the joint made. This was in April.

The second incident occurred on July 15 of this year. A stretch of supply main had to be lowered and its alignment shifted a few meters because of a relocation of the roadway. In this case a valve was available and the pipe was drained. Everything went well and the line would have been ready for use in a few hours had not leaks in some of the Victaulic joints delayed the work until 6 p.m. Meanwhile the temperature had dropped and the pipe had contracted so as to form a gap of 1 in. and make it impossible to make the last of these joints.

Resort was then had to heating the pipe to cause expansion. Beneath six pipe lengths, three each side of the gap, paraffin wax was poured on the ground for a length of 3 meters (10 ft.) at each pipe length, calking yarn having been placed under the pipe before the paraffin was poured. The yarn and paraffin were then set on fire. The resulting heat expanded the pipe and the breach so that the joint could be made. Water was turned on again at 7 p.m. No subsequent leakage appeared.

These experiences were the first troubles we have had with Victaulic joints since pipe with those joints were laid for a length of 13 km. (8 miles) three years ago, the pipe for the greater part of its length being exposed to the air and sun.

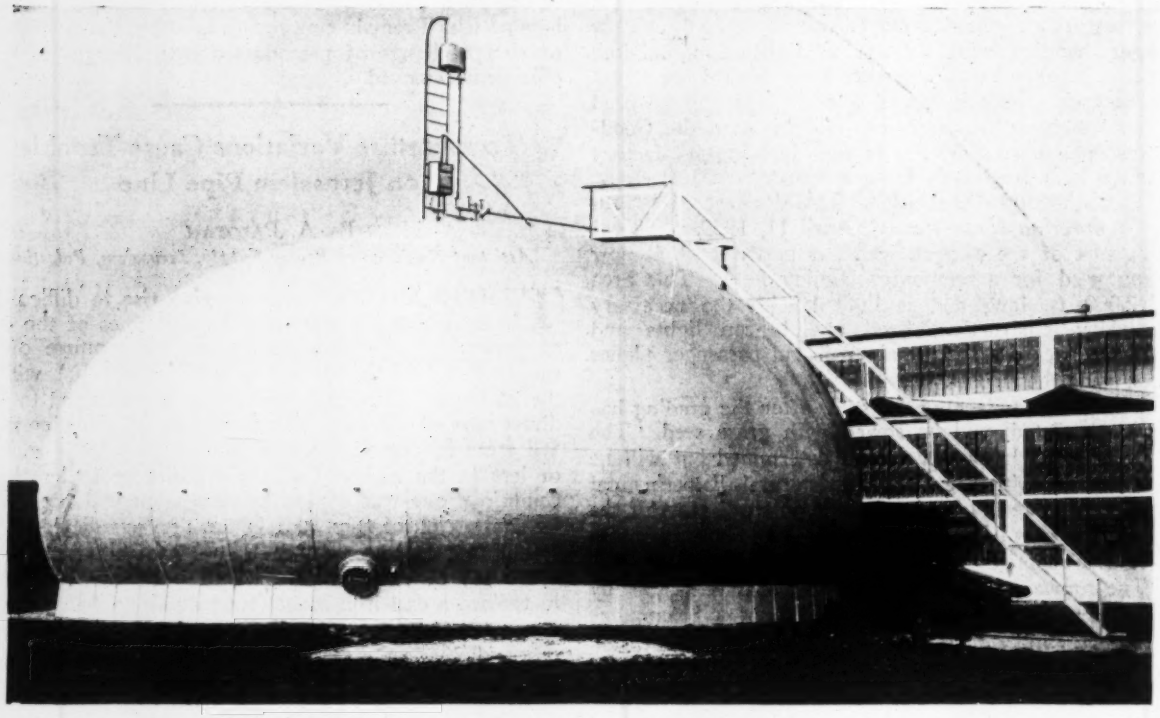


Fig. 1—Spheroidal Oil Tank, 10,000-Bbl. Capacity

New Spheroidal Design for Large Oil Tanks

Spheroidal Form Provides Economies in Designing Tanks for Either Gas or Oil or a Combination of Both—Tests of 10,000-Bbl. Experimental Tank Carried to Unintentional Extremes

By C. L. Day

Assistant Engineer, Chicago Bridge & Iron Works, Chicago, Ill.

THE IDEA of the spheroid shape for tanks was conceived by George T. Horton, president of the Chicago Bridge & Iron Works, which organization has spent several thousand dollars carrying on investigations for several years and actual experimental work for more than a year. The subject is divided into three parts: (1) the general theory on which the design is based; (2) a record of the actual experiments, and (3) the possibilities of the structure. Care has been taken to distinguish between theory, fact and opinion. A view and a drawing of the experimental tank are given in Figs. 1 and 2.

Theory of Design—The design of a tank or container for gas pressure and liquid pressure in combination is a problem which has long confronted structural engineers charged with providing storage for gasoline and oil. The requirements are as follows: (1) The container must withstand the stresses set up by being full of gas alone, full of liquid alone, or any combination thereof; (2) it must remain free from leaks under all conditions; (3) it must be economical.

Containers to meet these conditions have been made spherical and cylindrical with dished or hemispherical ends. These structures are satisfactory for small capacities, but beyond certain limits the construction becomes difficult and the cost excessive. Thus any extensive storage facilities must comprise a number of small units, which again increases the cost. From the nature of this type of steel plate construction its cost per pound will be more than that of ordinary tank construction. Therefore to be economical it will be necessary so to design the container that all material used will serve a direct purpose. That is, there should be as little tendency as possible to change shape, in order that there will not be a great deal of steel and work spent in stiffeners or girders, which serve only to keep the shell in proper shape.

The only way this can be done is to make the shape as near as possible that taken by flexible container under gas

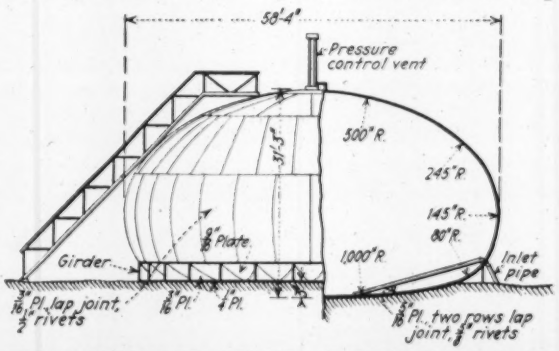


FIG. 2—DESIGN OF 10,000-BBL. EXPERIMENTAL TANK

and liquid pressure. This shape can be illustrated by partly filling a rubber balloon with water and placing it on a flat surface. Its shape will be that of a spheroid circular in plan, with a flattened bottom. This is the origin and general principle of the shape of the spheroidal tank.

Any given volume of liquid contained in a space of certain height will have approximately the same external bursting force through a vertical section. This is a fundamental law of gravity and no amount of designing will get away from it. In the ordinary cylindrical tank this entire bursting force is resisted by the vertical shell. But the roof and the bottom, which merely hold the contents, contain nearly as much material as there is in the shell.

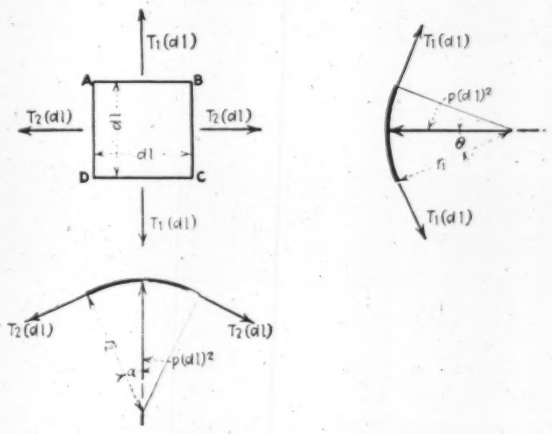


FIG. 3—DERIVATION OF GERMAN FORMULA FOR TANK DESIGN—$p = \frac{T_1}{r_1} + \frac{T_2}{r_2}$

Let $ABCD$ be a differential area with radius in one direction $= r_1$ and in other direction r_2
p = internal unit pressure
T_1 = plate stress in direction of r_1
T_2 = plate stress in direction of r_2
Σ = forces normal (in direction of p)

$$p\,(dl)^2 = 2T_1(dl)\,\sin\theta + 2T_2(dl)\,(\sin\alpha)$$

$$\sin\theta = \frac{dl}{2r_1} \qquad \sin\alpha = \frac{dl}{2r_2}$$

$$p(dl)^2 = \frac{2T_1(dl)^2}{2r_1} + \frac{2T_2(dl)^2}{2r_1} \qquad p = \frac{T_1}{r_1} + \frac{T_2}{r_2}$$

In the spheroid, the bottom, shell and roof form a more or less continuous curve. It thus transfers a considerable amount of bursting force into the shell and bottom and accomplishes the important feature of using all these parts for effective stress purposes. The spheroid has the further advantage of having the least tendency to change shape and therefore requiring the least reinforcement.

The spheroidal shape provides admirably for the conditions of a container full of gas or full of liquid. Gas alone tends to make the structure more spherical, and liquid alone tends to flatten it out. As long as these tendencies consist merely in a difference in quantities of stress or even in slight reversals at various levels nothing need be done. But study of the stresses reveals a certain section, near the bottom, wherein the tendencies to change shape exceed the limits mentioned and where some means of reinforcing must be adopted. The major portion of the high stress near the ground line can be eliminated by curving the bottom, a procedure necessary to a thin shell container subjected to the condition of gas pressure alone. Another point is that spheroids of large capacity will require some support for the top when the container is empty.

From a practical standpoint there is quite a range of shapes that can be chosen. There is one which gives a theoretical constant stress under the given conditions of gas and liquid pressure. This particular shape will require certain reinforcing under conditions of gas alone and also under liquid alone. If the shape were made more spherical, less reinforcing would be required for the condition of gas alone, but more would be required for the condition of liquid alone. If the shape were made more flat, the reverse would be true. The criterion of all designs being economy of material and labor, it is evident that the problem is not simply a matter of mathematical substitution. In fact, there are certain considerations which are not susceptible to mathematical analysis.

In most problems it is possible, by making the proper assumptions, to carry the theoretical mathematics to almost any desired extent, and especially is this true with the design of the spheroid. There are, however, only two formulas of any practical value in determination of stress. The first, Fig. 4, is given by Philipp Forchheimer in a treatise entitled "Die Berechnug Ebener und Gekrummter Behalterboden." The second, Fig. 5, was developed by the engineering staff of our company during the design of this structure. Their derivations are quite simple, as shown, and the necessary assumptions are: (1) that the steel plate does not act in shear or bending; (2) that the shape does not change; (3) that all stresses can be divided into two groups, vertical and horizontal.

With the formulas it is possible to draw the theoretically correct shape for any given set of conditions. This is done by first assuming a radius at the top of the tank.

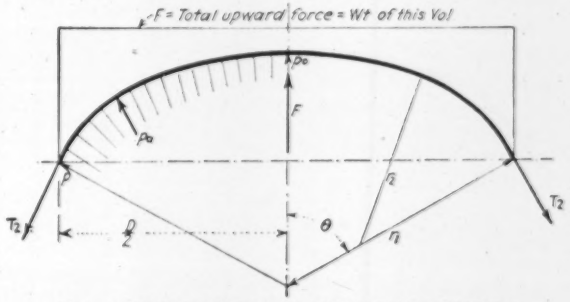


FIG. 4—DERIVATION OF AMERICAN FORMULA FOR TANK DESIGN—$T_2 = \frac{p_a r_1}{2}$

T_2 = tension per unit length at point considered
p = unit pressure at point considered
p_a = average unit pressure on section
F = total upward force
Σ = vertical forces

$$F = 2\pi\left(\frac{D}{2}\right)T_2\sin\theta \qquad \frac{D}{2} = r_1\sin\theta$$

$$F = p_a\,(\pi)\left(\frac{D}{2}\right)^2 = p_a\,(\pi)\,(r_1\sin\theta)^2$$

$$\pi\,p_a\,(r_1\sin\theta)^2 = 2\pi\,T_2\,r_1\,(\sin\theta)^2 \qquad T_2 = \frac{p_a r_1}{2}$$

The gas pressure and weight of liquid being already known, the stress per inch is known. A small part of the curve is drawn and the new pressures are computed. A new radius is chosen which compensates for the increased pressure, making the vertical stress constant. Another section of the curve is drawn using the new radius, and the process is repeated until the entire curve is traced. Fig. 5 gives a design of the theoretically correct shape for full gas and full liquid in the proportions shown. It will be noted that all the above-mentioned methods of determining a theoretical curve are "cut and try." No formula has been devised for predicting the volume before the curve is traced. As the volume is a definite amount and is entirely dependent on the variables mentioned, it seems that there should be an equation of the curve and a simple expression of the volume, but to date neither of these has been determined.

After the curve has been made, the next step is to compute the horizontal and vertical stresses for gas alone, for liquid alone and for a combination of liquid and gas. In the first place, the bottom will have to be curved from point 11, Fig. 5, using the radius which will take care of the stresses at point 12. But still the stresses at points 10 and 11 are excessive. Under gas pressure alone the tendency is to pull the shell in at that point, causing horizontal compression; and under liquid alone the overhanging load represented by volume *C* must be held up by the shell, causing vertical compression. A suggested method of accomplishing this dual purpose by means of triangular girders under the bottom curve is shown in Figs. 2 and 6. This method was tested on an experimental tank.

Experimental Spheroid Tank—In June, 1928, it was decided to build a tank of 10,000-bbl. (420,000-gal.) capacity and expose it to all possible conditions of loading. This tank (Figs. 1 and 2) is 31 ft. high, with a maximum horizontal diameter of 58 ft., and its form is such that the stresses on the shell are approximately uniform when it is completely full of liquid and subject to 5-lb. gas pressure. For all other conditions of loading, from empty with full gas pressure to full with no gas pressure, the structure tends to change its form. This tendency must be resisted either by the shell alone or with the aid of inside or outside reinforcement. The spheroid was built originally without any reinforcement. Its shell was of $\frac{3}{16}$-in. plates, with double-riveted lap joints and $\frac{7}{16}$-in. cold-driven rivets.

When the internal test pressure, from compressed air, reach 4 lb. per sq.in., a pronounced vertical buckle appeared in the lower portion of the shell, where our calculations showed the greatest compression stresses would occur. Then the spheroid was filled with water. When the height of water was 20 ft., with the spheroid about three-fourths full, there appeared just above the ground level a horizontal wrinkle, essentially uniform, around the entire circumference. Calculations showed

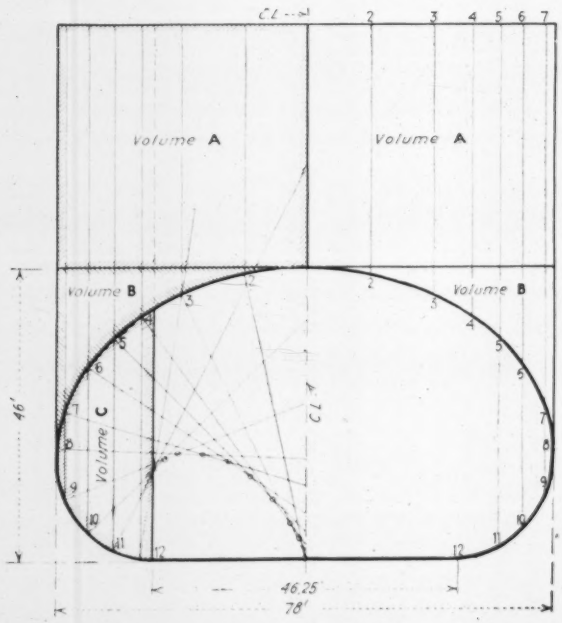


FIG. 5—DESIGN SHEET OF TANK

Volume *A* represents upward pressure due to gas; *B*, upward pressure due to liquid; *C*, downward pressure due to liquid

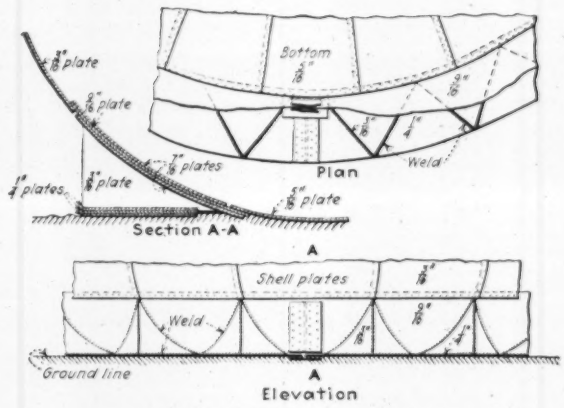


FIG. 6—TRIANGULAR RING GIRDER

that this wrinkle was caused by the overhanging load, accentuated by rather mucky soil at the ground surface. There was no rupture of plates and no particular leakage.

These tests having given the information desired as to the resistance that might be expected from the shell alone, we removed the horizontal wrinkle by introducing air pressure, reinforced the buckle by a few 4x$\frac{1}{4}$-in. bars tack-welded on the inside, and added a reinforcing girder triangular in cross-section, as noted above. It was welded to the original plates of the spheroid, none of which was removed. No framing was introduced inside. When 5$\frac{1}{4}$-lb. air pressure was introduced, no signs of distress appeared.

The spheroid was then filled with water without pressure and was found satisfactory with the exception of a small leak in the bottom. When nearly full, 5-lb. air pressure was applied and removed 150 times, after which the water was drawn out and the leak repaired. This leak was from a hole in one of the plates, evidently caused by careless use of a maul. Then the spheroid was again filled with water and 5-lb. air pressure was applied and removed 350 times. No leaks developed.

Evaporation Test—On Sept. 8 we placed 700 gal. of gasoline on top of the water, the gasoline being about 2 ft. below the top and forming a layer approximately 2 in. thick. The spheroid was closed and a continuous record of the changes in pressure was obtained by means of a recording pressure gage from Sept. 8 to Oct. 20. Charts taken before and after the tank was painted with aluminum showed the benefit of a light-colored paint, the pressure being about 1 lb. less after the paint was applied. The internal pressure never exceeded 5 lb., indicating no loss during the period of test.

An Unintentional Test—On Oct. 20 a workman happened to open the valve on the water pipe from the city main. This caused the pressure to rise and when it reached 5 lb. the vent opened, as intended. The foreman observed gasoline emerging, and with the thought of saving the gasoline he rushed to the top of the spheroid and closed the valve, not knowing that the water supply pipe was open. The closing of the vent subjected the spheroid to the full city water pressure of 45 lb.

The operator in charge of the test had the water valve closed and then opened the bottom drain, forgetting that the top vent was closed. Thus the spheroid was next subjected to a collapsible force resulting from at least three-quarters of a perfect vacuum. The operator hurried to the top to open a vent, and as he opened this he noticed the upper portion of the spheroid was depressed considerably, but this largely disappeared as soon as the

vacuum was relieved and was entirely corrected by filling the spheroid with water.

The tremendous stresses induced by this unintentional test caused numerous leaks, principally in the upper region where the stresses were highest. A 45-lb. water pressure at the ground level should cause stresses of 60,000 lb., or equal to the ultimate strength of the material. That it did not rupture was attributed to the fact that the spheroid is flexible and under stress will change its form, all such changes tending to reduce the stress. Even so, the actual stress must have been at least 53,000 lb. These stresses apply to the net section of the plates on the assumption that the joints developed 70 per cent efficiency. Evidently the stress in the main body of the plates did not pass the yield point, as no evidence of raising of scale or distortion of the paint is apparent. The numerous leaks in the joints evidenced the extreme stresses that must have existed therein.

Future Developments in Design—Study of the stresses occurring under the varying conditions indicates that a theoretical curve is not necessary and perhaps is not desirable from the point of view of economy of girder construction. A somewhat more economical design can be obtained by using a curve favoring the condition of gas alone.

Before the spheroid can be made practical it will be necessary to standardize its construction. This presents a number of difficulties. If the gas pressures are comparatively high, say 15 lb., it is not likely that the designs can be standardized except for individual sizes, nor that spheroids for this pressure can be made in very large capacities. The triangular girder method of reinforcing, or some modification of it, will undoubtedly work out best for these high pressures.

When the required pressures are 5 lb. and less, it is possible that spheroid construction can be standardized to a high degree by using internal bracing. This method has not been tried and there are several questions of judgment concerning its actual performance, the principal one being the action of the plates between frames and soil bearing. The first step is to standardize the curve of the shell. With this curve standardized for 135 deg. on each side, the desired capacity is obtained by simply moving the curved shells in or out. This changes the proportions of the spheroid and consequently the allowable gas pressure.

The two important conditions to investigate are that of liquid without gas and that of gas without liquid. For the first, the frames will be required to hold up the overhanging load of liquid, and for the second, to transfer sufficient outward force to the shell plates to balance the inward pull of the roof and bottom plates. Since the shell curve is to be uniform, the frames can be made standard for all sizes. A proposed frame for the condition of liquid only is shown in Fig. 7. This will be very nearly the same for all diameters. For gas alone, the most conservative method is to consider the shell plates as entirely flexible and being pulled over the frames by the stresses set up in the roof and bottom by the gas pressure. The reactions at the bottom and top of the frames must be supplied by a compression ring. Since these members would not act as compression members except under condition of gas only, they could be used as grillage beams to distribute the overhanging load under liquid only. This could be effected by placing shoes at frequent intervals beneath the lower girders.

Approximate estimates indicate a very considerable saving in weight of material of the larger sizes of spheroids. While difficulties in the development of this structure are to be expected, it is hoped that they may be successfully overcome. A tank of this form, with a capacity of 2,000 bbl. (84,000 gal.), 29 ft. maximum diameter and 25½ ft. high, has been built for the Sinclair Oil Company, at Wellsville, N. Y., and there are now under construction three other tanks at other locations 53 ft. in diameter and 39 ft. high with a capacity of 10,000 bbl. (420,000 gal.), all designed for 15-lb. gas pressure.

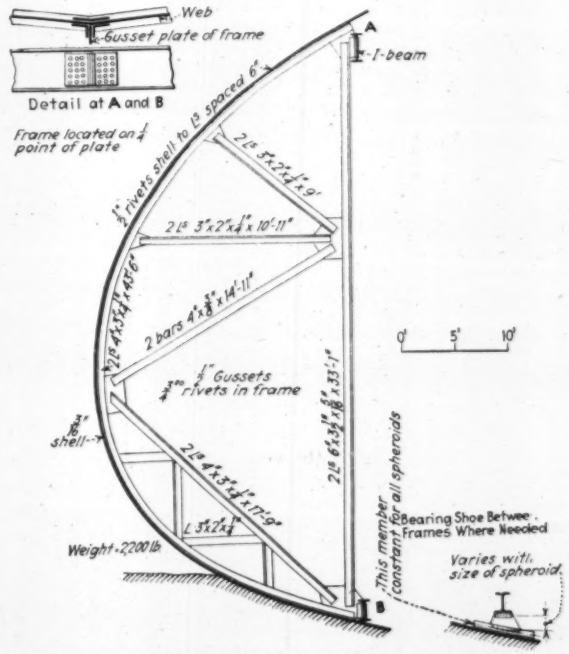


FIG. 7—PROPOSED INTERIOR BRACING FOR SPHEROIDAL TANK

Many States to Issue Road Bonds

Figures issued by the American Road Builders' Association show the importance of bond issues in highway financing, as evidenced by the fact that several states are planning to submit large bond issues to the voters in the near future for highway purposes. Among these states are Texas, with a proposed issue of $225,000,000; Oklahoma, from $100,000,000 to $150,000,000; Georgia, $75,000,000, and Iowa, $100,000,000. The latter is a resubmission of the bond issue passed last year but declared unconstitutional on account of defects in the bonding act. State legislatures in session so far during 1929 have approved issues in Maine of $15,000,000, in New Hampshire, $8,000,000, and in South Carolina, $65,000,000. Thirty-one states are using the bond issue method of financing highway construction.

Alaskan Aerial Survey Discloses Power Site

Discovery of a power site capable of producing more than 20,000 hp. is reported by the personnel engaged in making an aerial survey of hitherto unmapped regions in Alaska. The power site, which is situated in the Tongass National Forest in southeastern Alaska, is in a region containing a vast amount of pulp timber, enough to supply 25 per cent of the newsprint needs of the United States in perpetuity, according to the U. S. Department of Agriculture.

Trains of Portable Conveyors Place Concrete for Large Building

Forty-four Belt Conveyors on Carriages Assembled in Trains to Distribute Concrete From Tower Hoists Over 4½-Acre Floors—Eleven Similar Conveyors Unload, Stockpile and Distribute Aggregates

PROBABLY the largest plant of belt conveyors ever assembled for a single concreting operation is being employed in placing the floors and steel incasement for the new Merchandise Mart in Chicago. These conveyors are handling all the aggregates and distributing all floor concrete to the forms for an eighteen-story building covering an area of more than 4½ acres. Except for two fixed belt conveyors operating in tunnel under the sand and gravel stockpiles, all the conveyors are wheel-mounted self-contained machines, with 60- and 40-ft. belts and individual motors. The

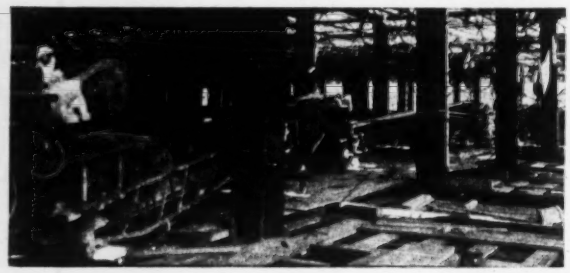


FIG. 1.—PORTABLE CONVEYORS DISTRIBUTING CONCRETE

At the left is the discharge end of one conveyor, while a fifth conveyor is beyond the last column at the right.

six machines for stockpiling aggregate are used in conventional manner, but the 44 units for distributing concrete are assembled in trains, sometimes on curved alignment, to carry concrete from tower hoists to floor forms. They will place about 140,000 cu.yd. of concrete.

The Merchandise Mart, which is said to be the largest commercial building in the world, with 4,000,000 sq.ft of rentable floor area, is an air-rights structure being built over the new freight terminal of the Chicago & Northwestern Railway in Chicago. The building, 324 ft. wide, has frontages of 724 ft. on Kinzie St. and of 580 ft. on the Chicago River, its west end being on a diagonal street. It will be eighteen stories high with a central tower of 25 stories. As the railroad has its tracks on the lower or basement floor and also has a team floor at the first floor or viaduct level, the warehouse property begins at 23 ft. above the water. The building is of steel frame construction, with reinforced-concrete floors and roof of the slab-and-joist type. Each floor has about 200,000 sq.ft. of net rentable area. About 140,000 cu.yd. of concrete will be required in the floors, column fireproofing and steel incasement.

Foundations—About 470 piers were carried down to hardpan at 70 ft. below water level, requiring some 46,000 cu.yd. of concrete. For this work, cement was delivered in bulk by a motor ship of 4,000-bbl. capacity and discharged by compressed air to an elevated bin of 5,500-bbl. capacity. Sand and gravel delivered on cars were unloaded by a locomotive crane with grab bucket and placed in stockpiles on heavy platforms beneath which ran belt conveyors. Each conveyor, loaded through traps, delivered material to a bucket elevator discharging into an elevated bin of 250-cu.yd. capacity.

Cement, sand and gravel flowed by gravity to batch-measuring bins, which discharged into chutes leading to two 1-yd. mixers. Concrete was discharged into a hopper for loading 1-yd. three-wheel motor trucks, which dumped the concrete in place. Placing this foundation concrete was begun Sept. 10, 1928, and was completed on Dec. 10.

Superstructure Concreting—For concreting the floors, two mixing plants were installed, one on the riverfront and the other at approximately the middle of the building, as shown by Fig. 3. Each plant has two 1-yd. mixers, overhead storage bins for cement, gravel and sand and two steel hoisting towers with 1-yd. buckets. For this part of the work cement is delivered by railroad cars; it comes in bulk and is forced by compressed air to either one of the storage bins.

As the erection of the steel frame had begun, it was not possible to unload cars of aggregate by locomotive cranes, therefore sand and gravel are brought in by hopper-bottom cars, which dump into track hoppers, from which the materials are taken by six inclined belt conveyors and delivered to stockpiles, as shown by

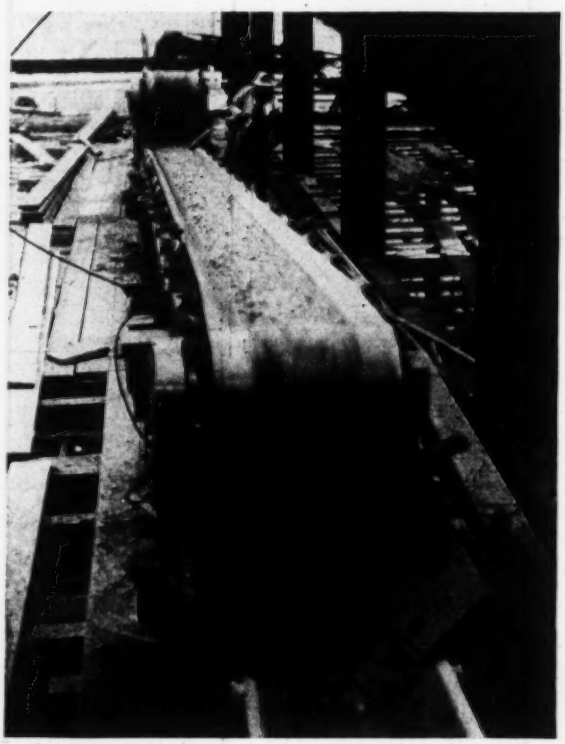


FIG. 2—CONCRETE TRAVELING ON CONVEYORS

Fig. 4. Four of the conveyors handle gravel and the others handle sand. They are all portable machines, mounted on trucks and utilize 24-in. cleated belts with an effective length of 60 ft. The six conveyors can stock about 40 carloads daily.

To serve the mixing plant on the riverfront there are two belt conveyors running in tunnels under the stockpiles and loaded by means of traps or gates. They discharge into two continuous bucket elevators (Fig. 4) supplying the overhead bins which feed the batch-measuring hoppers. Two similar belt conveyors in tunnels and two bucket elevators also serve the second mixing plant, but for this latter plant the elevators feed a second set of belt conveyors at the third floor, two carrying sand and one carrying gravel. These are continuous conveyors and carry the materials across the floor to the bins over the mixers, a distance of about 275 ft. for sand and 140 ft. for gravel. Thus eleven belt conveyors and four bucket elevators form the equipment for handling aggregate.

Each mixer discharges its batch of concrete into a 1-yd. elevator bucket, which is hoisted to a level about two stories above the floor which is being poured. There the bucket tips and delivers the concrete to a 1-yd. hopper, which feeds directly to an inclined chute, there

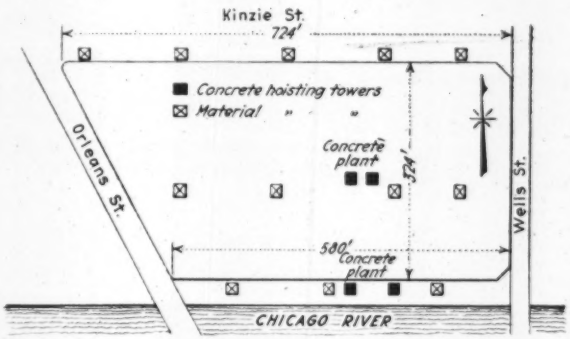


FIG. 3—LAYOUT OF HOISTING TOWERS
Four concrete elevator towers shown black. The others are material hoists.

being no gate on the hopper outlet. The chute extends to a 24-in. belt conveyor on the next floor below, or one floor above the one on which concrete is being poured. This conveyor is the first of a series of one to fifteen conveyors, arranged in straight or curved lines as required to reach the place of deposit. They are all 40 ft. long and are mounted on trucks with rubber-tired caster wheels to facilitate moving. Each belt discharges the concrete into a hopper at the receiving end of the next conveyor (Fig. 2).

There are 44 of these portable conveyors, used singly or in series as required. Each has its own electric motor with a cable for attachment to convenient plug outlets on the wiring system. At the normal belt speed of 250 ft. per minute each line of conveyors can handle about 1 cu.yd. of concrete per minute. The end conveyor discharges into an inclined chute, which delivers the concrete in place on the floor below. After a study of different methods of distributing concrete over such a large area, the portable conveyor system was adopted as being the most rapid and flexible, causing the least interference with other operations and requiring the smallest labor force. The floor being concreted is usually three or four floors below the steel erection, which proceeds without interference.

For mixing, hoisting, distributing, placing and finishing the concrete, there is a force of about 72 men. They work one eight-hour shift each day. An average of one shift of the four units is 250 cu.yd. of concrete placed.

Engineers and Contractors—Both the architectural and structural designs of the building were by Graham, Anderson, Probst & White, architects, for whom George W. Allen is superintendent on this work. The general

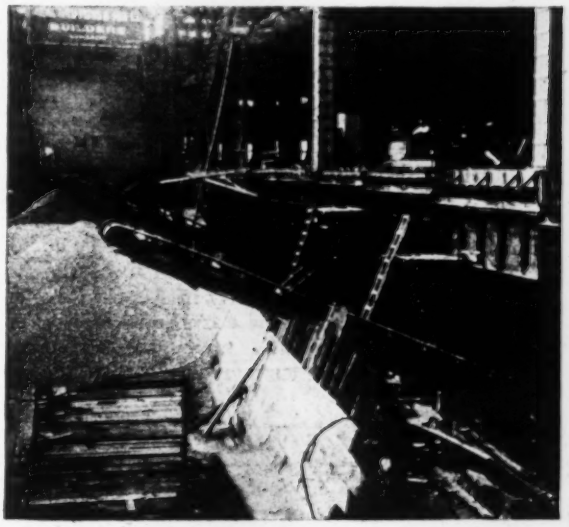


FIG. 4—CONVEYORS DELIVERING AGGREGATE TO STOCKPILES

construction contract was let to the John Griffiths & Son Company, which handles all concreting and steel erection with its own forces. The steelwork was fabricated by the McClintic-Marshall Company. All the construction work is in direct charge of Bruce Gordon, as general superintendent for the contractor. It is expected that the building will be complete by April, 1930.

Leeds Ship Canal Discussed

The Lord Mayor of Leeds, according to Consul A. R. Thomson, Bradford, in *Commerce Reports*, has arranged for a meeting in the near future to discuss the possibilities of a ship canal from Leeds to Goole, which would permit oceangoing vessels to come to Leeds from the eastern coast of England.

A canal from Leeds to Goole would be of about the same length as the Manchester Ship Canal (35½ miles), but in all probability it would involve a far smaller cost per mile, as the country in the main is level and open. From Goole the canal has been planned to follow the line of the present barge canal, which is 90 ft. wide, to Whitley Bridge, and would be opened out to 200 ft., in width, almost in a straight line. The whole route is free from rock, and for a great part of the distance on both sides of the canal the land is lower than the present water level, so that the excavated material would form the banking on the widened side. The rise in level to Whitley Bridge (14 miles from Goole) is only 13 ft. There would be six locks, which at 8 ft. 4 in. each would lift the ships 50 ft. from Goole Dock to the new docks in Hunslet which adjoins Leeds.

Pneumatic Caissons Sunk 110 Ft. for Vicksburg Bridge

New Mississippi Railway and Road Bridge Required Caisson Work Under 52-Lb. Air Pressure—Swift Current Demanded Unique Anchor Construction and Timber Mats to Prevent Scour—One Caisson Used as Diving Bell to Level Up Reef

By R. G. Stowell
Superintendent U.G.I. Contracting Company, Philadelphia, Pa.

SUNK by pneumatic caissons to the unusual depth of 110 ft. below water, all but one of the piers for the combined railroad and highway bridge across the Mississippi River at Vicksburg, Miss., were completed in a short low-water season last year by a high-speed construction program. Construction of the last main river pier was continued early in August this year having been held up since last December by high water. Several of the caissons required an air pressure of 52 lb.

The bridge will be the first to span the river between Memphis and the Gulf, a distance of 850 miles. It will carry an 18-ft. highway and a single-track railroad, both inside the trusses and at the same level. The Yazoo & Mississippi Valley and the Vicksburg, Shreveport & Pacific railroads will use the bridge, abandoning the train ferries which have existed for years at this point. The highway crossing connects with existing highways in the south end of Vicksburg and with the Louisiana state highway system at Delta Point on the west bank.

As shown by Fig. 3, the main river crossing, 2,931 ft. long, consists of a cantilever structure about 1,665 ft. long and four truss spans of the dimensions shown by the illustration. The railroad approach on the Mississippi side is a single-track spur about 4,000 ft. long with heavy cuts and fills and a 160-ft. tunnel, followed by 300 ft. of steel trestle from the abutment to east pier No. 1. A separate steel trestle carrying the highway deck reaches this pier on a curve from the north. Thence a deck truss 180 ft. long extends out to the east anchor pier of the cantilever span. The Louisiana approach consists of a steel trestle 4,110 ft. long and a fill 3,600 ft. long. Creosoted pine piles were driven to carry the concrete pedestals of the steel trestle.

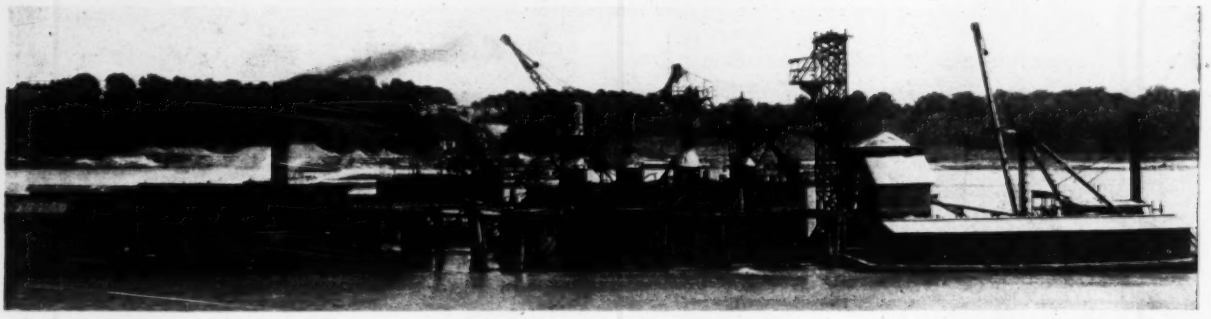


FIG. 1—SINKING CAISSON FOR PIER 6, VICKSBURG BRIDGE
Compressor boat shown at the left of the floating concrete plant and the sandhog house on the right of the caisson.

A cross-section of the floor is shown by Fig. 2. The highway deck consists of a reinforced-concrete slab 18 ft. wide and 6 in. thick, on a structural steel floor system. The railroad deck is open, with creosoted ties placed directly on longitudinal steel-girder stringers.

The substructure of the truss spans consists of eight piers, one on each bank and six in the river. The bank

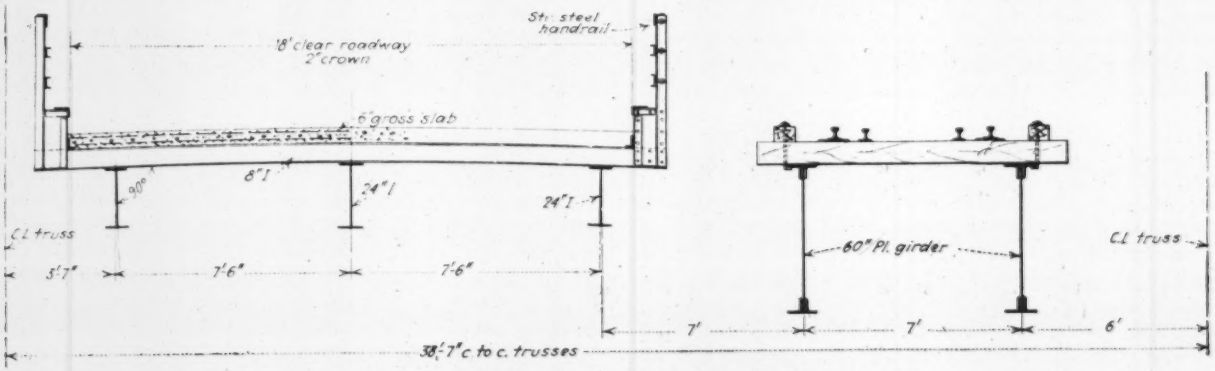


FIG. 2—CROSS-SECTION OF RAILROAD AND HIGHWAY DECKS

piers are carried on piling, the base of the west bank pier being 48 ft. below the ground line. The six river piers are founded on pneumatic caissons, their bases having the following dimensions: one 40x92 ft., one 40x80 ft., two 30x70 ft., one 28x68 ft. and one 25x67 ft. The bases are 50 ft. high topped by hollow shafts reaching in some cases to a height of 151 ft. Four of the pier foundations were carried 110 ft. below the average low-water stage. The foundation work required about 56,000 cu.yd. of concrete in the piers carrying the river span and about 10,000 cu.yd. of concrete in the approach trestle piers.

Construction Methods

The Vicksburg bridge is a toll bridge financed by private capital, and early completion was of the utmost importance. Contracts were awarded in February, 1928, and completion was contemplated by the end of 1929. Although any schedule that is contingent on favorable conditions in the Mississippi River is problematical, it appears that the bridge will be completed by the scheduled time.

Progress was dependent on the completion of the deep river piers. The practical working stage of the river, 20 ft. on the Vicksburg gage, meant that 50 lb. of air pressure, the practical maximum for caisson work, would be required with the cutting edges at grade on the deep piers. River records showed that on the average 150 days could be expected in a season by starting work on a 25-ft. stage and reaching 20 ft. or less during the latter part of the 150 days. The schedule was made on this assumption.

Ordinarily the 20-ft. stage would be expected about July 15, although in some few years it had been reached in May. This meant that equipment and organization should be lined up ready for starting in May if low-water conditions developed at that time. The season of 1928 proved an exception. Because of unusual high water in July a working stage did not prevail until Aug. 10, and early high water in the fall cut down the expected 150-day working period to 105 days. This prevented the construction of pier No. 4 until this summer, as high water prevailed from late last fall until Aug. 1 of this year.

Caisson Design—The original plans contemplated the use of all-timber floating caissons. At the contractor's request these were changed to permit the use of steel caissons 20 ft. high surmounted by timber caissons 30 ft. high and a timber cofferdam. This design permitted quicker construction and launching of the caissons. Further advantages were that reinforced concrete and steel were used instead of timber in the sides and roof of the working chamber, providing a tighter structure which was desirable in work involving high air pressures, and allowed more room in the working chamber by eliminating the rods and braces required in timber construction.

In order to have them ready in the event of early low water, the caissons were built and launched as rapidly as possible and tied up afloat until needed. They drew about 7 ft. when launched; after launching, the walls of the working chamber were concreted, causing the structure to draw about 13 ft. The timber work was then started, and concreting followed in lifts of 3 to 4 ft., each foot in height of concrete increasing the draft about 2½ ft.

The timbering and concreting were continued until the caisson was just floating with its cutting edge close to the riverbed. After careful lining up, enough concrete was poured to land the structure on the bottom and to offset the buoyancy resulting from putting air on the working chamber.

Landing the Caissons—Two of the caissons were sunk in comparatively shallow water, using the customary pile dock or slip for holding and lining the structure while afloat. These docks consisted of a decked pile trestle open at the downstream end. Besides assisting in landing the caissons, the decks provided space for material and machinery.

A departure from the usual method of landing caissons, with a detachable cofferdam in which the shaft is built up after the caisson is landed and sealed, was necessary for the four deep piers. As the nature of the foundation material required that the weight of the piers be kept as low as possible, the caisson bases of the deep piers were only 50 ft. in height. In the deepest piers, when the cutting edge of the caisson reached final grade, there was more than 60 ft. of shaft of the finished pier poured. This required unusual care in handling and sinking so that when landed and sealed, the top of the shaft would be in accurate position. In the early stages of sinking, with practically no skin friction developed on the caisson, the heavy weight of the structure made handling difficult. Fig. 1 shows the sinking of the caissons for pier 6.

Caisson Anchors—Because of the swift current, special anchors were developed to assist in landing and sinking the caissons. One type consisted of a concrete mushroom about 7 ft. in diameter and 2½ ft. high built around a light steel framework having a vertical member 7 ft. long with a shackle at the end for fastening the anchor cable. These mushroom anchors weighed about 9 tons each and were very effective in sand bottoms. If necessary they could be readily jetted down into the sand for additional holding power.

Two of the caissons in the deepest water required a heavier anchor. These consisted of 16-in. H-beams from 18 to 30 ft. long, fitted with a shackle near the top for cable connections, driven into the river bottom nearly full length. The anchors were driven 600 ft. upstream from the piers in water up to 70 ft. in depth by using

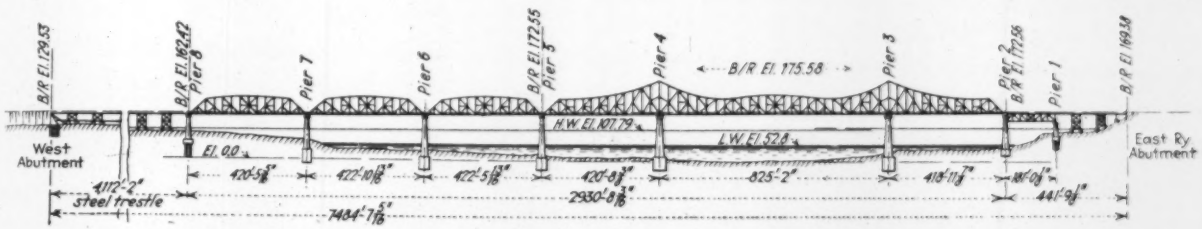


FIG. 3—GENERAL ELEVATION OF THE MISSISSIPPI RIVER BRIDGE AT VICKSBURG, MISS.

a special type of follower. Five of them were used for each caisson and they proved very effective, especially in hard material. Wire rope cables 1½ and 1¼ in. in diameter were run from the pile anchors to an anchor barge placed midway between the anchors and caissons. On the barge, connection was made between the cables leading to the anchors and those going to the caisson by steel rope blocks and falls, which permitted control of the caissons in landing and sinking. The effective use of this anchorage system permitted the sinking of the deep piers without the use of a cofferdam or guide piles.

Progress of Sinking—In soft material the sand was removed from the working chamber by blowpipes. Hard material was removed by ¾-yd. buckets operating through the material locks.

Five caisson piers were completed in four months, four of which were in deep water and one of which went to a depth of 112.3 ft. below water. Pier 6 was sunk 80 ft. through sand in 22 working days. Pier 3, which is located on a reef of hard material, was sunk through 75 ft. of hardpan in 33 days. The last 17 ft. of pier 7 was sunk at the rate of 7½ ft. per day, the material being all sand.

Despite the large number of sandhogs employed and the high air pressures used, there have been no fatal cases of the bends, or any case causing permanent disability.

The site of pier 7, above low-water line, permitted the use of an all-concrete caisson. The entire working chamber and sides were built of reinforced concrete and the caisson was sunk for the first 50 ft. by open dredging, after which the pneumatic method was used.

Caisson Used as a Diving Bell—Before landing the caisson of pier 3, it was necessary to use the caisson as a diving bell to level up the site. This pier, which carries the east end of the cantilever span, is located on a reef, part of which is soft rock and the remainder a very hard clay. At low-water stage there were 30 ft. of water and a fairly swift current in the river. In the 40-ft. width of this caisson the reef had a slope of about 7 ft. toward the channel. The riverbed was very irregular and the material was too hard to dig with a dredging bucket to level off the site for landing the caisson. Time did not permit of rigging up a submarine drilling and blasting outfit to level off the bottom. Therefore the caisson itself was used as a diving bell.

Derrick stones were dumped into the low places and the caisson was towed into place and concreted until its shoe floated just clear of the riverbed. Sandbags were deposited around the outside and the caisson was flooded with enough water to overcome the buoyancy developed by the air pressure. Air was put on and sandhogs worked inside, leveling up the bottom and removing obstructions. After the river bottom was leveled, the air was taken off, the water ballast pumped out and the caisson floated. Concreting was then resumed, the caisson being guyed accurately to position and sunk in the same manner as for the other piers.

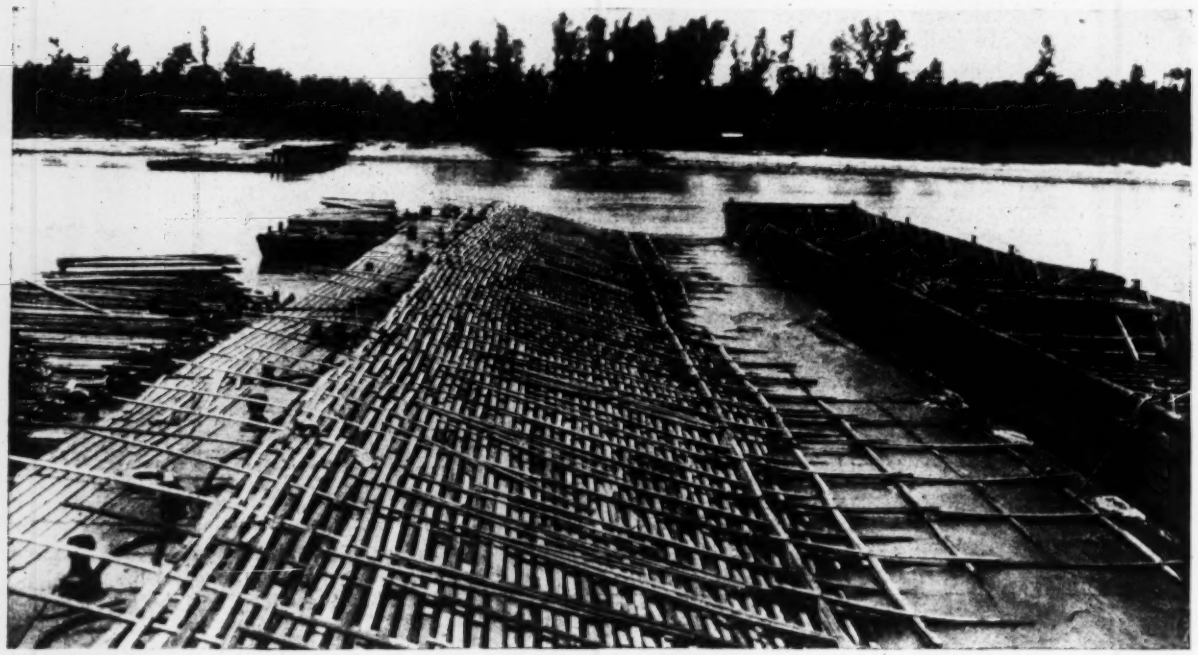


FIG. 4—WEAVING ONE OF THE TIMBER MATS PLACED TO PREVENT SCOUR

Lumber Mats Prevent Scour—To prevent scour at the three piers located on sand, the plans provided for placing either lumber or willow mats to be constructed according to the U. S. Engineers' standard specifications. Lumber mats were used, woven of 1x4-in. boards, and were sunk by weighting with one-man stones. The mats were 400 ft. long and 250 ft. wide and centered with the piers. They were constructed on barges at the pier sites as shown in Fig. 4.

Plant and Organization

Because of the short working season, it was necessary to have enough equipment and men to work simultaneously on two of the deep river piers, the shore piers, the approaches and topping out the river piers as the foundations were completed. This required about twice the amount of plant that would ordinarily have been used on such a job. Three steam-operated compressor boats were used for supplying air to the caissons, two on steel barges. These floating plants had 3,000 cu.ft.

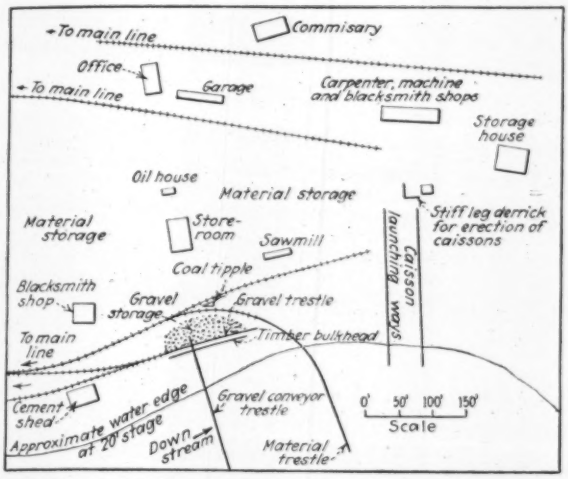


FIG. 5—MAP OF THE CENTRAL PLANT LAYOUT ON THE VICKSBURG SIDE

per minute capacity. Derrick boats with 75-ft. boom revolving steam cranes were used in place of the usual stiff-leg derrick mounted on barges. These proved very satisfactory because of the stabilizing influence of the counterweights in all positions of the boom. Also these cranes could be quickly fitted for work on land when needed. Two floating concrete plants were used, one of 1½-cu.yd. and the other of 1-cu.yd. capacity. Both plants were equipped with storage bins loaded by a stiff-leg derrick handling materials from barges alongside. Each floating plant had a hoist tower, one being 125 ft. high, for use in topping out the piers. A complete fleet required for building one pier is shown in Fig. 1.

A locomotive crane was used in the yard work, three crawler cranes on the approach work and in material handling, and three revolving cranes on wide-gage track, two with 85-ft. booms, were used on the shore piers for land piledriving, and when needed were run onto barges to supplement the derrick boats. A large fleet of barges was available for handling sand, gravel, cement, coal, timber and piles. Steel barges were used in most cases. Most of the equipment was designed and developed especially for this job.

During the peak of operations, more than 700 men were employed, 300 of them being sandhogs. A system of ferry transportation was operated between the base yard and all portions of the work for the distribution of the men. Gasoline-operated boats carrying 40 men each were on a definite schedule 24 hours a day. Despite the frequent changing of shifts, especially of the caisson workers, the men were handled without confusion or loss of time.

Central Base and Material Yards—Convenient railroad facilities were obtained on the Mississippi side about a mile above the bridge site, where a central base and material yard (Fig. 5) was established. Separate yard tracks were built to handle each class of material. A trestle carried one track out into the river as a dock, permitting easy transfer of material from cars to barges. Gravel was dumped from a trestle permitting storage of 1,200 cu.yd. Under the stockpile a short tunnel was built through which a belt conveyor operated to a dock, where the belt discharged directly into barges. At one end of the yard were the launching ways for the steel caissons. The base yard also contained offices, storehouse, sawmill, carpenter shop, machine shop and blacksmith shop.

A separate plant layout was built on the Louisana side for the construction of the long approach trestle. A light pile dock out in the river was connected to the shore by a trestle carrying a narrow-gage railroad track. This track continued inland along the center line of the trestle piers, and all material and concrete were handled over this railway. Concrete was furnished by one of the two mixer plants used for the river piers. From the floating plant the concrete was chuted into 1-yd. bottom-dump buckets set on flat cars. The cars were hauled along the track to the site of operations and the dump buckets were handled directly to the forms by crawler cranes. The foundation piles for the approach piers were driven with swinging leads handled by a wide-gage revolving crane carrying an 85-ft. boom.

Contractors and Personnel

The bridge is being constructed for the Vicksburg Bridge & Terminal Company, Harry E. Bovay, president, as a toll bridge. The total cost will be about $7,000,000. The design was made by Harrington, Howard & Ash, consulting engineers, Kansas City, Mo., who are also supervising the construction. P. V. Pennybacker is resident engineer for the consultants. The American Bridge Company is contractor for the steelwork of the river spans and east approach, and the Virginia Bridge & Iron Company furnished and erected the steel for the west approach trestle. J. A. Kreis & Sons Company is contractor on the tunnel and grading work. The U.G.I. Contracting Company, of Philadelphia, a division of the United Engineers & Constructors, Inc., is contractor for the river piers and Louisiana approach substructure. Woods Brothers Construction Company, of Lincoln, Neb., built the channel mats, and the St. Louis Structural Steel Company designed and built the floating steel caissons, both acting as subcontractors to the U.G.I. company, for which F. S. Harvey is field supervising engineer, with the author as superintendent and John R. Flick and James J. Dennedy as assistants.

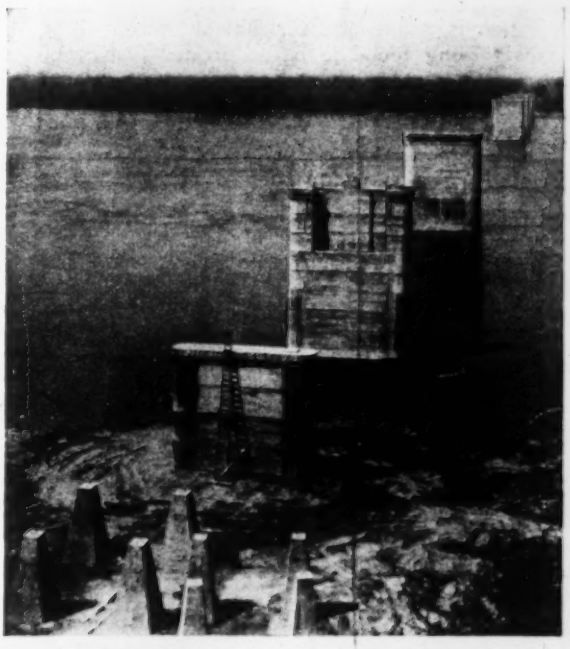


FIG. 6—RIVER PIERS COMPLETE EXCEPT PIER 4

Models Verify Observed Behavior of Hackensack Bascule

Counterweight Oscillations Not Damped by Friction if Trunnion Shaft Has Greater Angular Velocity Than the Counterweight

IN ORDER to confirm the observations made on the operating leaf of the Hackensack double-leaf trunnion bascule bridge, following the collapse of the other half into the river (*Engineering News-Record*, Jan. 10, 1929, p. 74, and Aug. 29, 1929, p. 340), Prof. G. E. Beggs, of Princeton University, who was a member of the investigating board, made several experimental studies.

It was observed at the bridge during the motion of the operating leaf that the initial oscillation of the inverted counterweight pendulum persisted, undamped by the friction of the supporting trunnion. This phenomenon was brought to the attention of Prof. C. H. Willis, of the electrical engineering department of Princeton University, who has had considerable experience in the mathematics of harmonic analysis. The conclusion indicated by his analytical study of the phenomenon was that the oscillation of a pendulum will not be readily damped by friction of the supporting shaft if that shaft rotates at a greater angular velocity than the maximum angular velocity of the oscillating pendulum, as was the case at the Hackensack bridge.

To check this conclusion, Professor Beggs made the model shown in Fig. 1. From a dry unlubricated wooden shaft, a wooden pendulum weighted with 40 lb. of iron is suspended. The shaft can be turned or held fixed at will by means of the crank. An index pointer placed so as to make contact with the swinging weight enables one to gage the rate at which the oscillation is damped. When the weight is drawn back to the index pointer and released, while the supporting shaft is held fixed, the oscillation of the pendulum is damped completely after ten swings. However, if the shaft is rotated at a moderate rate so that the slip of the shaft in the pendulum bearing is always in the same direction, the oscillation is maintained for 200 or more swings, the damping being found to be no greater than when the pendulum has a knife edge support. This phenomenon is important, for it emphasizes the necessity of taking persistent oscillations of this sort into account when designing bascule bridges.

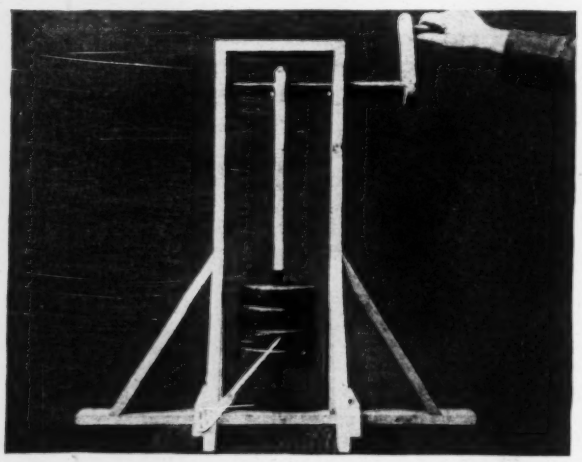


FIG. 1—OSCILLATION DAMPING APPARATUS
Model planned to show inability of trunnion friction to damp out counterweight oscillations. Horizontal shaft with crank corresponds to counterweight trunnion and the pendulum to the counterweight and its supporting shaft.

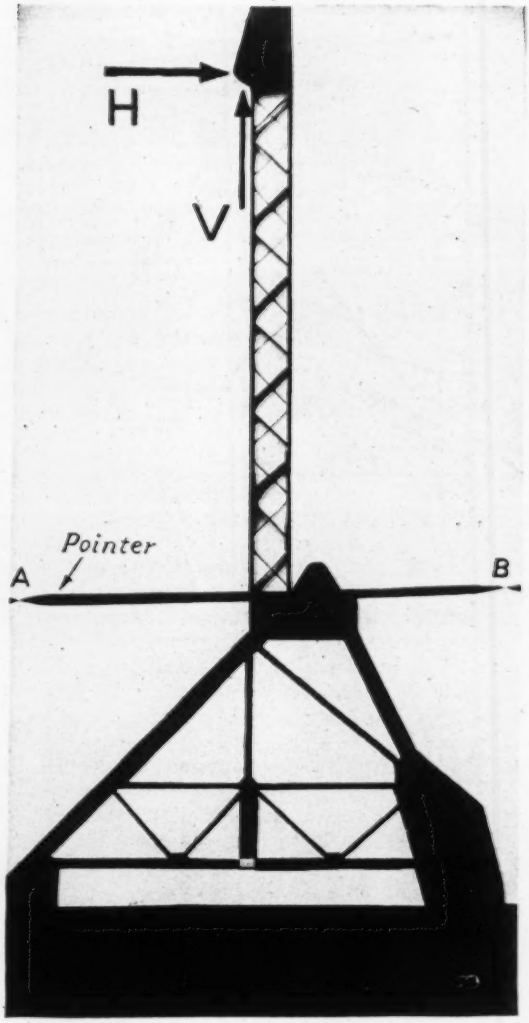


FIG. 2—CELLULOID MODEL OF A FRAME AND COUNTERWEIGHT TOWER

Another observation made at the bridge indicated that the top of the A-frame supporting the counterweight tower tipped back and forth through a readily measurable angle during the operation of the bridge. To confirm this elastic action of the structure, Professor Beggs cut a celluloid model of proportionate stiffness (Fig. 2). This model can be deformed by H and V forces applied at the top of the counterweight tower, in a manner similar to the force acting at the upper link pin of the steel bridge. By means of the double pointer, registering against the fixed index marks *A* and *B*, the rocking of the top of the A-frame is evident as the top of the counterweight tower is bent back and forth.

A second observation made from this model is that secondary bending occurs in the two vertical members of the counterweight tower. These members are deformed into a multiple number of reverse curves as the tower is deflected by an H force, this action being a result of the eccentricity of the connections of the lacing members with the vertical members of the tower.

Irrigable land on the Yakima Project in Washington

Many Economic Problems Involved in Proposed Changes in Public Land Policy

Future of Land Reclamation Work Is an Important Problem—Federal Aid for Highway Construction in Public Land States Also Affected—Control of Erosion Involved in the Amount of Grazing Permitted

By Kendall K. Hoyt
Of the Washington Staff, Engineering News-Record

Following Secretary Wilbur's commitment to some form of state jurisdiction over the public domain, President Hoover presented a tentative but detailed plan to this end in a message read by the First Assistant Secretary of the Interior, Joseph M. Dixon, at a meeting of Governors of the public land states held in Salt Lake City on Aug. 26. The Wilbur statement was discussed on p. 137 of *Engineering News-Record*, July 25. The following article by Mr. Hoyt, which brings the situation up to date, is based on interviews with many of the leading authorities on public land problems. —Editor.

PRESIDENT HOOVER'S proposal to cede the unreserved surface of the public domain to state control promises to become a major step in the economic history of the nation. Although the plan is unlikely of adoption in its present form, some action is almost sure to follow, with lasting consequences to the entire West. The full effect has hardly been realized because of the thought that grazing on relatively worthless land is the only problem involved. From the grazing standpoint alone the transfer would be of no small moment, but other and larger issues are drawn into the picture. Of these, the probable upset in the federal-aid system is most important, as will be shown.

Forests and Minerals Out

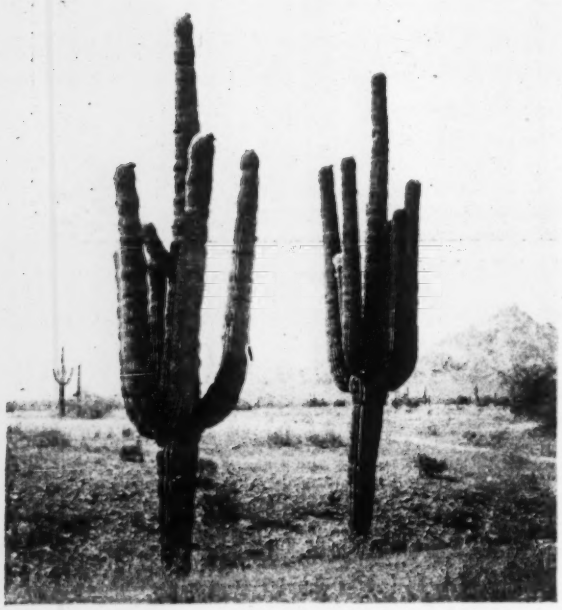
To narrow the discussion, all reserves of a national bearing—the minerals, forests and power—may as well be eliminated at the start. Mr. Hoover excepts them from his plan, and even if he did not, Congress undoubtedly would vote down any measure, such as the perennial bill introduced once more by Senator King, of Utah, for the disposal of national assets of such huge value. One conservative estimate appearing in an Interior Department report gives an ultimate appraisal of $12,000,000,000 for the minerals, $1,000,000,000 for the forests and $300,000,000 for the grazing lands. This is a guess, but it gives some idea of relative values.

Of course, some of the Western states consider a transfer of the surface rights as an entering wedge toward the control of the other reserves. Thus they have not officially committed themselves to the Hoover plan, but have consented to let the matter be threshed out before a commission with the hope that further conces-

sions may be offered. If not it is believed that they are likely to balk at acceptance of the surface only. It is true, however, that they would still receive full benefit from the minerals, for under the present plan 52½ per cent of the royalties go to the reclamation fund, 37½ per cent to the state treasuries and only 10 per cent is used for federal administration. The real deprival may be expected in the curtailment of federal-aid activities. Development of the land surfaces will cost more than the probable returns for some years to come; hence the states would stand to lose by the transfer unless assured of continued support from the national treasury.

Federal Aid a Main Issue

Whatever the intent, the government engineering functions are almost certain to undergo important changes both in scope and in policy. The present system is based



TYPICAL GRAZING LAND WHICH BECOMES FRUITFUL UNDER IRRIGATION

mainly on the apportionment of co-operative funds according to the areas of federal land within state boundaries. Although Mr. Hoover intends to continue the present aid and Congress might do so for a limited time, it is logical to suppose that the attitude of future Congresses would be quite different toward state-owned areas than toward the present public domain. Thus the burden of expense would fall more and more on the states, with a consequent decentralization of engineering activities.

Against this possibility Mr. Hoover proposes that public road construction be continued for at least ten years on the present basis. Also, it is believed possible that the investigations of the Geological Survey and the Bureau of Mines could be maintained with some few changes in financing. The Forest Service and the Indian Service would not be affected, since the land they cover would not change hands. The Corps of Engineers is hardly concerned.

Reclamation on New Basis

Reclamation, however, is supposed to be slated for an entirely new set-up. On that score the President has some definite and significant things to say which are worth a deviation for separate study. Mr. Hoover suggests that the Reclamation Bureau "be reoriented primarily to the storage of water" and that its administration be simplified. Since the service began in 1902, he says, conditions have changed materially and, with a total expense of $182,000,000 from the reclamation fund, large federal administrative activities have grown within the states to an extent which never was intended. In many ways, he points out, this control duplicates the state water administration, by which it could better be handled. Mr. Hoover's tentative suggestions are as follows:

"The Reclamation Service for all new projects might well be confined to the construction of permanent works—that is, dams and such construction as results in water storage—and at the completion the entire works be handed over to the states with no obligation for repayment to the reclamation fund except such revenues as might arise from electrical power, and possibly in some cases from the sale of water, until the outlay has been repaid, or in any event for not longer than 50 years.

"Again, there are certain instances of insufficiently capitalized community-owned irrigation projects which are at the point of failure for which the reclamation fund might be made a proper vehicle to rescue homes that are now in jeopardy. A further activity which might be considered would be the authorization to join the states and local communities or private individuals for the creation of water storage for irrigation purposes."

A Radical Departure

This suggestion is viewed as a radical departure from past practice. Even though the fund results from the use of the Western resources under federal care and should rightfully go for Western uses, the diversion of this great public trust to revive sick projects is believed to be a risky business. Experience directly along this line in connection with projects developed under the Smith and Cary acts, legislation for the benefit of private and state irrigation schemes, has been unfortunate. There are too many projects in the West which never should have been built and which never would have been built were it not for the quick promotion profits. Even though the bondholders and settlers are left in a bad predicament, additional financing usually is like pouring water down the proverbial rathole.

Carefully devised checks and counterchecks would be needed to avoid trouble. Thus President Hoover recommends that all new projects drawing from the fund should be approved by Congress as at present. The existing projects would not be affected. Water power, navigation and flood control are concerned incidentally to the storage works built for land development. Mr. Hoover explains that the effect of his plan is purely local, because the increased production from further reclamation of farming land would not be felt in national markets for at least twenty years, by which time new land probably will be needed anyhow.

Description of Lands

Returning to the grazing problem, which is of the greatest immediate concern and around which the other issues hinge, the first question is the extent and character of the land involved. The total area is about 237,000,000 acres: 194,000,000 unreserved vacant land, 35,000,000 over the surface of mineral reserves and 10,000,000 of stock drive and water-hole reservations. About 90 per cent is arid country between the Rockies and the Sierra Nevadas. Large areas have rainfall ranging from 8 in. down almost to zero. There are few permanent streams

except those rising in more moist uplands. Farming without irrigation is out of the question. This leaves grazing the sole surface use.

The land can be divided roughly into foothill and desert types. The former classification makes up about one-third of the area and is mainly good grazing land as it stands. Sagebrush, piñons and juniper are the principal vegetation. The desert types are relatively worthless; some put them at no value at all, pending the spread of some new forage plant like spineless cactus.

Effects of Overgrazing

Regulation of grazing on the open ranges has been often advised but never attempted. Therefore abuses have occurred, with the result that lands once covered with bunch grass "up to a horse's belly" now are stripped almost bare and are steadily approaching the appearance of some Asiatic landscapes. Destruction of the forage growths permits erosion and the washing out of plant foods from the soil, a little-understood process of vast importance in national economy. An indirect result is the silting of streams. Recent reservoir silting on certain irrigation projects is chargeable to preventable overgrazing. These effects are enough to merit action regardless of possible future changes in runoff and climate.

Fencing goes a long way toward improvement. More water holes, tanks and reservoirs are needed. To make this possible, some tenure under a licensing system is necessary. The statement is made that individuals cannot afford to spend money on public land without the power to keep others off. The land in question is worth so little that the government cannot induce people to take it as a gift and pay taxes. In fact, only a third of the original federal holdings in this region have been patented, railroad grants included. The grazing problem must therefore be handled for a long time at a loss under a firm and uniform policy if the damage is to be remedied.

Mr. Hoover wants the government to admit defeat before it has started, and unload on the states. In this he and Secretary Wilbur stand almost alone. Mr. Dixon's speech blows hot and cold on the matter, at one point lauding the ability of the states to handle their own problems and later saying that the Roosevelt policies, first distrusted, "saved them from themselves." The President fears bureaucracy on the one hand and on the other, from his Western outlook, is more optimistic than most concerning the ability of Western legislatures. Though he may be right and state control may prove preferable, comment in Congress, which body will have the final say, is so nearly unanimous against the plan that it seems impossible of adoption.

Federal Control Needed

Supervision by one agency under a constant policy seems preferable to a division of control with several vacillating policies. For one reason, the unreserved land must be operated as a unit with the national forests, two-thirds of which are licensed for grazing purposes. The former is winter range and the latter is summer range. Though the available forest area is smaller, a fair balance exists between the two. Herds are driven back and forth over long distances to meet seasonal changes, often crossing state lines.

It is needless to enumerate in detail the difficulties which would arise under separate managements. A clash in policy would be inevitable. The Forest Service favors the little fellow to encourage local settlers. The states might be expected to avoid expense by turning over the lands as soon as possible to large firms ready to finance them. This would drive the small herders out of the forest as well as off the open ranges by taking their winter forage. Nevada, which is three-fourths public land, including a quarter of the unreserved domain, is pointed out as an example. The population is centered about the capital away from the ranges and is principally concerned with mining. Quick disposal of the lands would be logical rather than to spend large sums on a shadowy future. Once in private hands, the case is hopeless, for no ordinary mortal will guard against or even notice a slow erosion of, say, 1 per cent per year. Experiment stations equipped to observe, plan and put their results into use are needed to cope with such a problem.

Whether called bureaucracy or by any other name, the Forest Service control of grazing has been well handled. Some areas which never did bear and never will bear trees, where conditions are similar to the open ranges, have been made forest reserves and the grazing capacity increased several fold by proper measures.

The settlement of claims and the handling of future applications would be a perplexing problem under state control of the surfaces. Would mineral grants include surface rights as at present? Would precious metals be reserved along with the oil shale, coal, oil and potash? These questions might be answered by wise rulings, but it would seem that widespread confusion and litigation would be not least among the results of state control.

On the whole, it appears that at present the ranges should be controlled by a licensing system tied in with the Forest Service, the Public Land Office and other bureaus handling the national problems of forest, power and mineral resources. The problem is no simple one. No wonder Governor Dern, of Utah, remarks, "What seems to be a fine white horse may prove a white elephant on closer inspection." It will be only by the detailed study of a well-chosen commission that a proper solution can be reached.

Dock System Completed in London

With the official opening in September of the Port of London Authority's improved accommodations at Tilbury, London became possessed of the most up-to-date dock system in the world. Built at a cost of $15,000,000, the improvements include an entrance lock with a rolling lift bridge over it for road and rail traffic; a dry dock 750 ft. long by 110 ft. wide; a passenger landing stage 1,142 ft. long and an imposing luggage hall. At the river end of the lock jetties of timber piling form a bell-mouth entrance to the three sets of gates. The dry dock, 750 ft. long, can, if necessary, be extended to more than 1,000 ft. Mechanical bilge blocks, devised to obviate the use of the usual wooden shores, are a feature of the equipment. They are brought into position under the keel of the ship, while it is docking, by hydraulic power. Another interesting device is a leading-in girder which insures the centralizing of the vessel when floating in. Four huge pumps will empty the dock when the ship is inside.

The passenger landing stage at the other side of the dock is supported by 63 large pontoons. Five bridges are provided to the shore for pedestrians, vehicles and luggage, and passengers will be within 20 yd. of their train when disembarking. The old Tilbury depot has been demolished and the new one will be in use early in 1930.

Letters to the Editor

China's Progress in Road Construction

Sir—In your editorial of Aug. 22 issue commenting on a world movement in roadbuilding, there is a statement that "China perhaps excepted, more roads and better roads are a controlling motive of development in virtually every country of the globe." I do not see what makes you think that China should be excepted from this movement.

It is very unfortunate that what you read in the papers is either fighting or trouble in China. The reporters seem to be quite war-minded; they prefer to stir the public with wars rather than with any news of improvement or progress. I am sure there is more fighting on the front page than there is on the "war front."

A good road movement was started in China a number of years ago by Dr. C. T. Wang, the present Foreign Minister. Since then more roads have been built than ever before. I am sorry I cannot give you any definite figure of the progress made, because no available information is at hand, but I hope to report some to you when I go home. From letters I have received I know that there are buses and automobiles running between my home town and others which I had never seen when I left home about five years ago.

The government is launching a big program of reconstruction; railroads, highways, water supply, sanitation and all that are included. A vast country like China cannot be expected to jump up in a day or two. There is no doubt that she will need your shovels, road machines and, above all, your services and sympathy. So why not give up such a wrong and undesirable idea that China is always a backward and stagnant nation, void of any improvement, and give her a more guiding thought and constructive advice? There is nothing more gratifying than to do something for the neediest, even in a land far away. JAMES E. P. TAI.

Elmira Heights, N. Y.,
Aug. 27, 1929.

Preventing Percolation Through Dams

Sir—I have read with considerable interest the article by N. A. Bowers on "Effect of Percolating Water on Concrete Dams," appearing in *Engineering News-Record*, Aug. 8, 1929, p. 212. The title of the article may well have been "Causes, Effect and Prevention of Percolation of Water Through Concrete Dams," as Dr. Bowers has covered these items quite thoroughly.

There is one point I believe overlooked by Dr. Bowers, and that is the need of a pozzolanic constituent in portland cement to combine with the calcium hydrate therein, forming insoluble calcium silicate, thus preventing the leaching out of this free lime and at the same time making the concrete more impermeable as the reaction takes place between lime and pozzolanic silica in the presence of water.

Perhaps more emphasis should be put on technological control and workmanship. The competent concrete physicist can determine field proportions for concrete mixtures having the optimum of essential workability, impermeability, strength, weight and density. However, careless measurement of the constituents nullifies the laboratory work; and careless workmanship in placing and in management of placing equipment will segregate the most perfect mix into rock ("honeycomb") at one point and mortar at another.

It should be appreciated that production and testing of aggregate, the testing of cement and the testing, proportioning, mixing, placing and curing of concrete constitute the technological process of the manufacture of concrete, about the only manufacturing process in the province of the civil engineer. Manufacture of concrete on major projects is not a simple matter of haphazard workmanship and arbitrary proportions. Essential workmanship requires the skill of the practical concrete artisan, and quality and workmanship with economy require adequate manufacturing equipment and the skill of the practical and scientific concrete technologist, the civil engineer specializing in concrete production. Withal, the concrete technologist must have authority (consistent with the responsibility) throughout the technological process of aggregate and concrete production—the testing, proportioning, measurement, mixing, transporting, placing, curing and cleaning of the concrete. There are examples of leaking dams where the concrete technologist recommended mixtures but had no executive authority in the workmanship of production.

A standard test for impermeability of dam concrete, as suggested by Dr. Bowers, is one of the needs of the day. However, no form of laboratory test will, alone, insure technological skill in the workmanship of mixing, placing and curing. There must be "concrete sense" on the job as well as in the laboratory, and vice versa. I say "and vice versa" because an appreciation of water-cement ratio, and cement content, and grading, and strength, and density and impermeability, without an appreciation of workability, flowability and cohesion of the concrete as essentials is not "concrete sense," is neither scientific nor practical.

The trial of arbitrary mixtures in the structure and proof seven to 28 days thereafter is a usual practice and one of the causes of percolation in dams. While 25 to 50 per cent excess cement is advisable under this procedure, excess cement is not a sure means of prevention of percolation; it may be adulterated by silt, vitiated by organic matter, dissipated by excess sand, diluted by excess water and the mix segregated by poor workmanship in handling.

Arbitrary proportions are unreliable, because the aggregates may be fine one day and coarse the next, well graded and then poorly graded, the mix workable and then impossible, etc. An absolute basis mix structure should be determined by comprehensive preliminary tests, the strength, density, weight, impermeability, water-cement ratio, slump and flow of the concrete determined and this basic structure of the mix, in content of absolute volumes of mixing water, cement and aggregate particles of various diameters, maintained by continuous testing of the materials and reproportioning as the physical characteristics of the materials vary.

Specifications are not always adequate. There is an efficient ratio of man-hours of laboratory control to volume of production and also of man-hours of placing labor to production, and these are seldom provided for in the specifications. Slope of chutes, slope of bin bottoms; measuring, mixing and placing equipment; the number and maximum and minimum sizes of aggregates; the order and manner of pouring; definition of the responsibility and authority of the assistant engineer, the concrete technologist and the inspection staff; all are subjects of adequate specifications. Finally, specifications should be based on sound technical knowledge of the physics of concrete and on practical experience with proved concrete production methods.

Dr. Bowers' statement, "A large dam built five years ago under the most careful supervision in the control laboratory has constantly leaked about 2 sec.-ft. since it was put into service," suggests two conclusions—either Dr. Bowers is mistaken as to the competence of that laboratory control, or the engineer in charge of the laboratory control of the concrete was limited as to authority or facilities, as has been indicated in the foregoing. JOSEPH A. KITTS.

San Francisco, Calif.,
Aug. 23, 1929.

Keeping Concrete Pipe Damp During Curing

Sir—In your issue of Aug. 8, on p. 220, you briefly describe two methods of keeping concrete pipe damp during the curing period. The method you describe of covering the pipe with burlap and wetting it down from time to time is not the method followed by this company, although we cover the pipe with burlap and wet it down. Our method consists of standing the pipe on end close together on the curing ground, which is covered with fine gravel and cement and is provided with some drainage. The pipe is then carefully covered with burlap, the edges well overlapping and coming to the ground on all sides; the burlap is then weighted down at the ground on all sides and on the top. In this way the pipe is fully inclosed and no air can circulate within it. The burlap is kept constantly wet throughout the curing period, and in this way the pipe is kept thoroughly wet and in a humid atmosphere. All sprinkling is done by hand.

We have found this method far superior to that of stacking the pipe and depending on spraying the pipe on the sides and over the top. We find that in this dry climate it is practically impossible, following such a method, to keep all pipe thoroughly wet.

In a warm climate the method we follow is equal to steam curing in a closed room.

MERCEDES CONCRETE PIPE COMPANY,
By W. F. Shaw,
Vice-President.

Mercedes, Tex.,
Aug. 13, 1929.

Standing-Wave or Hydraulic-Jump Flumes Again

Sir—In your issue of July 18 is a letter from my very good friend C. C. Inglis, superintending engineer, Irrigation Development and Research Circle, Poona, India, which in the interests of an international good understanding of the hydraulic engineers operating here below should, mayhap, not remain without answer. So long ago as upon the building of the Menai tubular bridge—a horrible iron tunnel hoisted into the air and thus thrown across a sunlit arm of the sea by Great Britain's most distinguished engineers—it was remarked that it is characteristic of English engineers to overcome what the engineers of most other countries avoid. Nor has this example of persistent force and engineering skill of its kind ever found an imitator outside of the British Empire; as witness the metal lattice bridges built elsewhere in Europe; the panel trusses developed in this country and now generally adopted the world over. This writer very much fears that a fate similar to that accorded the Menai tubular bridge awaits the East India standing-wave masonry flume; and a pity it is, at that; for it is, like the bridge, the outcome of some exceedingly fine, even brilliant, mathematical and engineering, and, in the case of the flume, patient and able hydraulic work.

But this is a practical world, a world of survivals of the fittest, and what chance has a finely formed masonry submerged hump or weir, surmounted by masonry structures, one of whose claimed advantages is that these may be used as bridge abutments, against a simple, specially shaped tube put in as a part, in length, of the normal channel of conveyance; even if it should appear eventually that at Poona, where the assistant engineers and workmen wear breechclouts and turbans and very little else, the standing-wave flume be practical—masonry there is so cheap—to the exclusion of other forms of flowmeter.

Says my good friend Inglis, "When the problem is the measurement in open channels, standing-wave (hydraulic-jump) flumes have several important advantages," 1, 2, 3, 4, 5: Less cost, wider range, only one reading, proportional supplies, can be used as bridge abutments. These claims it will be necessary to review.

1. *Less Cost*—Nothing so easy in a general engineering criticism as to claim less cost. I am reminded here of the like claim made in favor of the weir by an engineering educator of youth when he was asked to rank the Venturi meter in water-power water-metering operations as something superior to being herded along with certain antediluvian operations under the heading "Other Methods" in his text book on Water Power. To him this "device" was not warranted where "large quantities of water (!) have to be handled," and among other things "registers" must be installed. Just as though the Venturi meter was not born without a register attached and could not at any time be used with only pencil and notebook, instead of with register and recorder, if desired.

Nor can temporary water-metering structures be compared with meters that last as long as do the pipes or penstocks of which these last form a longitudinal part. The cost and quality, for an engineer, depend largely on the material and manner of construction, and cannot merely be read out of a sales catalog or from the replies received as offers made in accordance with general specifications.

Similarly, but by contradistinction in a markedly kindly manner, Mr. Inglis. He was no doubt comparing, in his mind, the cost of a single Kent special-casting Venturi meter fitted with automatic register and recorder with the present cost of one masonry hydraulic jump, both set in place, *in Poona;* irrespective of the fact that to the first it costs nothing worth mentioning to turn out a continuous record, while for the second to produce such a thing would require at a minimum a crew of three turbaned individuals constantly on duty. Or, if only occasional readings were required, a material part of the metal Venturi meter could be dispensed with, as likewise the cost of the register and recorder. Again, the meter tube, all but the throat piece, need not be of metal. It can be made of wood, or of concrete, plain or reinforced. Those same breechclouted artisans that build those precisely molded submerged humps or weirs of the standing-wave flumes would find no difficulty whatever in doing it.

There remains the great problem (I purposely am confining this discussion to a consideration of irrigation requirements) of the conversion, for a short length, of the open channel into a closed pipeline. But this was solved in practice years ago by J. Waldo Smith in the construction of the Catskill or Ashokan water supply to the city of New York, if not before then. The three 17-ft. diameter reinforced-concrete Venturi meters that meter, in series, this New York water supply form part of the conduit that conducts the water to the city, and the open conduits upstream and downstream from the meter tube are connected by building the meter tube on the level and in the line of an *inverted siphon.*

It is doubtful whether the masonry of the three Ashokan 17-ft. Venturi meters cost any more than the equal necessary length of normal conduit would have cost had no Venturi meters been put in.

And even irrigation service has long since supplied examples of masonry Venturi meters. There is the Acquedotto Pugliese, in southern Italy. It supplies water for both domestic and irrigation uses to several hundred communities, and I have been told has 400 Venturi meters on it, all made of concrete though I should think that the throat pieces would be made of metal.

2. *Wider Range*—Not materially wider, if at all, when one knows how to design them both. Siemens & Halske, of Berlin, by a skillful compounding of several Venturi meters have attained a range of 1 : 140. See *Gas und Wasser* of April 19, 1929.

3. *Only One Reading*—Not of material moment; but if desired the Venturi meter reads itself, by means of one of many kinds of registration or recording devices now on the international market.

4. *Proportional Supplies*—We shall claim that one is as good on this score as the other.

5. *Can Be Used as Bridge Abutments* — Let us say, granted.

Do, Mr. Inglis, introduce, if you have not already done so, the Venturi meter, *built in the main and on the spot by your own people,* in East India irrigation practice.

CLEMENS HERSCHEL.
Glen Ridge, N. J.,
Aug. 28, 1929.

Habits of Mosquitoes

Sir—Owing to a drought of six months' duration, water is supplied through the distribution system of Santiago de Cuba once every seven days—different parts of the city being supplied on different days. It is therefore necessary in most cases to store the water in barrels to tide over the seven days. A plunge or shower bath is out of the question.

In my own case I fill the porcelain bathtub and three barrels placed in the bathroom (besides others for kitchen service, etc.). Although the house is screened, mosquitoes get into the house, and it is necessary to use an exterminator sometimes, and although the barrels are covered with beaverboard, mosquitoes manage to breed in them, and they have invariably mosquito wrigglers in them; but with respect to the white porcelain bathtub, although not covered, there are no mosquito larvæ in the water at any time. From this fact I judge that the mosquito prefers to breed in water having a dark background as have most pools and quiet streams, and that if open barrels or other tanks containing water were painted white inside they would possibly be kept free from mosquito larvæ.

WILLIAM A. WILSON.
Santiago de Cuba,
Aug. 5, 1929.

News of the Week

Hoover Willing to Hold Up Doubtful Flood-Control Work

Raising of Mississippi Levees to Be Continued—Decision Up to States Involved

By Paul Wooton
Washington Office, Engineering News-Record

A WILLINGNESS to hold up work on those features of the Mississippi flood-control plans upon which there is a pronounced difference of opinion, if the Senators and Representatives of the states concerned so desire, was expressed by President Hoover in a statement made at the press conference at the White House on Tuesday. President Hoover's statement is as follows:

I have a question of the lower Mississippi flood-control work. On behalf of Secretary Good and myself I have informed Senator Robinson, of Arkansas, that if the Senators and Representatives of the interested states are willing to assume the responsibility by making the request, then we will delay the undertaking of the new work on that portion of the Mississippi flood control, covering the so-called floodway from the Arkansas River to the Gulf. That segment of the flood-control work represents about one-third of the total expenditure. There has been a great deal of division of opinion, and many views have developed lately on both technical and other questions and I want to give full consideration to those views before settlement is finally arrived at.

That will not involve the other major features of the flood-control work—that is, the strengthening of the levees on the main river and the tributaries and the New Orleans spillway, or the realignment of the river levees on the Missouri side south of Cairo.

The principal features involved are the Boeuf and Atchafalaya floodways.

As this is written there is some question as to the position the Mississippi Senators and Representatives will take. There is doubt as to their willingness to assume responsibility for what might happen in the event of a flood too great to be carried safely between the main river levees. Whether or not the President will be influenced if their signatures are withheld is problematical.

Senator Ransdell, of Louisiana, a member of the commerce committee, and Representative Wilson, of the same state, ranking minority member of the flood-control committee, are certain that the formal request suggested by the President will be forthcoming. They state that they will be glad to assume their part of the responsibility and express the opinion that the President's statement means that all available funds and every effort will be concentrated on levee and revetment work until the diversion phase of the plan can be reviewed and reexamined. They also say that it opens the way for constructive amendments of the flood-control act. No changes can now be made without an act of Congress.

Engineers Chosen to Select Route for Colorado River Aqueduct

Announcement of the appointment of three engineers who are to serve as a board of review whose duty it shall be to select the route to be followed by the Colorado River aqueduct has been made by the board of directors of the Metropolitan Water District of Southern California. These engineers are A. J. Wiley, consulting engineer, Boise, Idaho; Richard R. Lyman, consulting engineer, Salt Lake City, and Thaddeus Merriman, chief engineer of the Board of Water Supply, New York City.

The appointment was made on the recommendation of the district's committee on consulting engineers, of which Prof. Franklin Thomas, of the California Institute of Technology, was chairman. In making the selection it was decided that of the three members of the board of review two should be from the West with special knowledge of Western water problems and the third should be an Eastern man recognized as pre-eminent in the field of water-works engineering. It also was decided that in considering candidates for membership on the board of review residents of the states of California, Arizona and Nevada should be excluded, as it was felt that any engineer residing in those states might be regarded as a prejudiced authority.

Maine Rejects Bill to Export Surplus Water Power

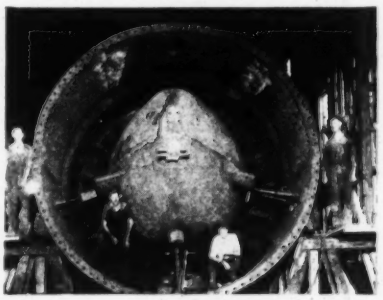
On Monday, Sept. 9, the citizens of Maine rejected the Smith-Carleton bill, which authorized the issuance of permits for the sale of the state's surplus water power outside of the state, which is now prohibited. Returns from 582 out of 632 precincts in the state showed 61,699 against, 54,047 for. The unreported precincts are in sections known to be against the bill.

The subject was one for lengthy debate in the last session of the legislature. The act as finally passed provided for the imposition of an excise tax of 4 per cent on the gross revenue from the sale of surplus water power, no tax being assessed for the sale of power within the state. Surplus power was defined as the quantity in excess of the requirements for local needs. Provision was made for the organization of corporations to buy and sell power, but no such corporation could own, operate or control any hydro-electric generating plant or electrical company. Surplus power could be sold only by corporations obtaining stipulated permits. Both the new corporations thus organized and the plants from which these bought electricity could send current outside the state on sale, but the former could not sell inside the state.

New Orleans Streets Under 6 Ft. of Water Following Heavy Rain

Pumping Capacity Exceeded by 10.75-In. Precipitation—Property Damage Heavy

HEAVY rains accompanied by thunderstorms and high wind along the Gulf Coast area resulted in severe damage to the city of New Orleans, where streets and buildings were flooded to depths as high as 7 ft. during the early morning of Sept. 7. No lives were lost, although it was necessary to remove many persons from their homes by boat. Practically the entire city was affected,



LARGE DRAINAGE PUMP SOON TO BE INSTALLED AT NEW ORLEANS

and all traffic was suspended for several hours.

Details of the flood are given in the following telegram received from George G. Earl, general superintendent of the New Orleans Sewerage and Water Board:

Sewerage and Water Board rain gages overflowed at something over 10 in. of rainfall for the second time since 1894. United States record 10.75 in., nearly all falling from 5 p.m. to 3 a.m. This exceeded any prior rainfall for a 35-year period except that of Good Friday, 1927, and was probably very nearly equal to this in the uptown area. The maximum depth of water in various uptown portions of the city was nearly as much as caused by the former rain; apparently the intensity for several hours was at least as great. This time there was, however, no major accident to the power system, which operated constantly to full capacity. By about midnight Saturday the canals were brought down to around their theoretical flood slopes. Sunday, on driving through the area which was flooded the deepest and longest, I saw very little sign of any after effect from the flooding.

It required about 31 hours' full capacity to pump off this almost unprecedented rainfall, counting from 5.30, when the first flood wave in excess of capacity reached the nearest pumping station. This wave had barely been reduced to a little below flood slope when the second and vastly greater flood wave started. With the substantial doubling of power pumping and outfall capacity which is now under contract the removal of even such a rainfall should be accomplished in about sixteen hours and the depth and duration of delayed removal correspondingly decreased.

The enlargements to the drainage system referred to by Mr. Earl include

the installation of seven of what are said to be the largest drainage pumps in the world. These are of the low-head, screw type, ranging in diameter from 14 to 18 ft. Each will be driven by a 2,000-hp. 6,000-volt motor and will discharge from 1,000 to 13,400 sec.-ft. under varying heads. In addition, five smaller pumps will be installed to bring the total pumping capacity to approximately 28,000 sec.-ft.

Union Freight Terminal Designed for New York City

A union freight terminal to handle the less-than-carload lots of non-perishable shipments, both inbound and outbound, of the eleven trunk-line railroads serving New York City will be erected within the next fifteen months by the Port of New York Authority on the West Side somewhere between Canal and 21st Sts., it was announced this week. Preliminary plans for the building are ready and 60 per cent of the site has been acquired. A statement issued by the Port Authority says:

General plans and specifications for the building have been under consideration for some time and are practically perfected. It will occupy an entire block about 200 ft. wide and 800 ft. long. It will be fourteen stories in height above the street, with a basement and sub-basement. The exterior will be simple, dignified and pleasing. The construction will be of reinforced concrete with brick veneer, terra cotta ornamentation and granite base, modern, fireproof and fully sprinklered, with adequate provisions for power and light requirements and large window openings. The basement will be used exclusively for freight facilities of the operating railroads.

The central portion of the street floor (removed from the main avenues) will be used as an inbound and outbound freight station, with all standing trucks within the building lines. Each end of the main avenues' frontage (first floor) will contain a passenger lobby, passenger elevators, service elevators, service lobby, platform and storefronts. Separating the avenue frontages from the freight station, ramps for motor access to the basement and second floor are contemplated. Eight freight elevators in the center of the building connect all floors with the freight station facilities.

The inland terminal plan contemplates stopping the inbound freight cars at the railheads where bulk is broken and transferring their contents to trailer trucks or containers, which will be carried by motor trucks to the inland stations. On the outbound freight the process will be reversed.

Shipments of freight inbound will be brought in full truckloads to the inland station, where the freight will be assorted into smaller lots for the receivers, who will call for them with their own trucks. Movement of outbound shipments will come to the inland or union station platform from trucks of the shippers and a group of trailer trucks for each of the several railroads will receive them.

Panama to Hold Road Conference in October

The Panama Cabinet has accepted a suggestion of the Pan American Union for a highway conference to be held there in October, when the five delegates from the United States to the Second Pan American Highway Congress at Rio de Janeiro will be in the country en route home. The United States delegates are expected to arrive in Panama City Oct. 7. The governments of Mexico, Guatemala, Costa Rica and Salvador are reported to have accepted invitations to participate.

Pan American Meeting at Mexico City Plans Permanent Organization

Engineering in Two Continents to Be Field Covered—The 1931 Gathering in Denver

By Donald M. Baker
Vice-President, American Association of Engineers

Attended by Mexican engineers and a group of approximately 125 engineers and their families from the United States, Panama and Cuba, with official delegations representing the American Association of Engineers and the Panama and Cuban engineering societies, the first Pan American Engineering Convention, held in Mexico City, Aug. 25 to 31, developed a firmly expressed attitude of the value of such meetings and a desire for the creation of some organization which could act as a vehicle for carrying on the work initiated at the first meeting. The convention was called by the Centro Nacional de Inginieros de Mexico on the occasion of its seventh annual convention. This is a national society comprising about 700 members.

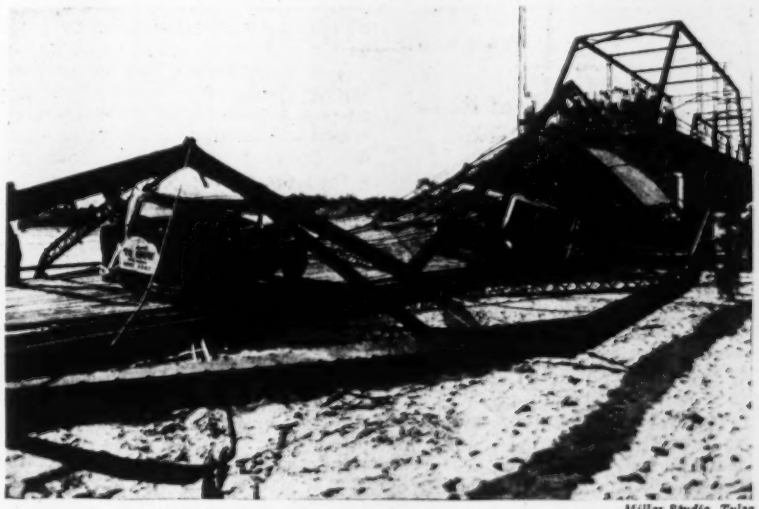
Business meetings were given over primarily to the discussion of plans for a permanent Pan American Engineering Association, and the place and time of the next meeting. Official representatives from foreign countries were Donald M. Baker, of Los Angeles, Calif., Arthur Richards of Trenton, N. J., and Harold Boedtker, of El Paso, Tex., representing the American Association of Engineers; Manuel Palaez, of Havana, Cuba, representing the Cuban Engineering Society, Ernesto J. Guardia, of Panama, representing the Panama Engineering Society, D. J. McQuaid, of Denver, Colo., representing the Colorado Engineering Council, and Pecos H. Calahan of Glendale, Calif., representing the Structural Engineers Association of Southern California.

The convention was organized Aug. 25, with the following officers: honorary president, J. Sanchez Mejorada, Secretary of Communications and Public Works of Mexico; executive president, Alfonso Costello, president, Centro Nacional de Inginieros; vice-presidents—Panama, Ernesto J. Guardia; Cuba, Manuel Pelaez; United States, Harold Boedtker and Donald M. Baker. The general secretary is Armando Santacruz, Jr., Juarez, Mexico, and the treasurer Augustin de los Cobos, Mexico. Seventeen directors were chosen from members of the various engineering societies in attendance.

The next meeting will be held in Denver in 1931; invitations are to be sent to all engineering societies in North and South America and the West Indies. It is proposed to develop at this meeting a permanent form of organization for calling meetings of Pan American engineers and engineering societies to consider common problems.

A number of papers were presented by Mexican engineers in manuscript form. These will be printed both in Spanish and in English in the proceedings of the convention. The major part of the time, however, was taken up in inspection of engineering works.

BRIDGE COLLAPSES WHEN STRUCK BY MOTOR TRUCK



Miller Studio, Tulsa

What happens when a light steel truss bridge has a panel post knocked out by a heavy motor truck is graphically depicted in this illustration, showing the results of an accident to the Sand Springs bridge over the Arkansas River at Sand Springs, Okla. The structure consists of 116-ft. spans with a 16-ft. roadway. Top chords and batter posts are made up of two 6-in. channels with 12-in. cover plates. The second intermediate post, consisting of two 4-in. laced channels, was struck by a truck, resulting in the jack-knifing of the entire truss and its precipitation into the dry bed of the stream 20 ft. below. A new span was fabricated, erected and opened to traffic within six days of the accident by the Patterson Steel Company, Tulsa, Okla.

Cracked Reservoir Lining Causes Concern at Burbank, Calif.

Discovery of cracks on Sept. 7 in the concrete lining of a 7,000,000-gal. water-supply reservoir at Burbank, Calif., caused city officials to order immediate draw-down through the emergency valves to safeguard the 700 residents in the area below the reservoir. The two-year-old structure is situated at an elevation of 200 ft. above a residential district of the city and according to reports has not shown evidence of leakage prior to the present time. Safety measures used in addition to opening the emergency gates included opening fire hydrants and urging persons who might be endangered in the event of a flood to leave the district temporarily. The situation was relieved after discharging about 2,000,000 gal. from the reservoir. Investigations are now under way to determine the cause of the cracks. A preliminary survey is reported to show that the cracks occurred in a part of the reservoir located on partly filled ground.

All But San Franciscans Barred on Hetch Hetchy Project

A resolution has been passed by the San Francisco Board of Supervisors authorizing the establishment of a free employment office by the Board of Public Works to secure workers for the construction work on the city's Hetch Hetchy project. The resolution provides that all non-citizens of the United States now employed on the project shall be discharged and that all employees not residents of San Francisco shall be replaced by San Francisco residents as fast as such persons can be obtained to fill the jobs. The resolution was carried by a vote of eleven to one.

Survey to Be Made of Road Traffic in Western States

In order that the federal government and the Western States may know what the flow of traffic is throughout the year on the main transcontinental highways and on other roads in the federal-aid highway system in the West, the highway departments of Washington, Oregon, California, Idaho, Nevada, Wyoming, Utah, Arizona, Colorado, New Mexico and Nebraska and the Bureau of Public Roads of the U. S. Department of Agriculture will make a traffic survey over a period of one year, beginning this month.

The survey will show the number of vehicles using each of the main highways throughout the year, by days of the week and hours of the day, and the number of vehicles passing a given point at certain times of the day. It will classify the traffic according to types of vehicles, whether passenger cars, motor trucks or motor buses, and the number of passengers in passenger cars. The importance of cities, towns and sections of the state as the source and destination of traffic will be ascertained, and the number of vehicles from other states using the highways, and other information required by state and federal highway officials, will be obtained. The data will show population trends and will be useful in solving traffic regulation and safety problems. Surveys will be conducted simultaneously in each of the states.

Civil Service Commission to Fill Important Denver Post

The United States Civil Service Commission states that the position of senior mathematician, Bureau of Reclamation, Department of the Interior, with headquarters at Denver, Colo., is vacant, and that in view of the importance of the position and to insure the appointment of a thoroughly qualified man for the work, instead of the usual form of examination, the qualifications of candidates will be passed upon by a special board of examiners.

The duties of the position are to make special studies of a highly technical nature concerning mathematical treatment of arch dam designs in connection with the Boulder dam construction, to design important structures of a highly specialized nature and other engineering services as required. The entrance salary is $5,600 a year.

Applications will be received by the Civil Service Commission until Oct. 2.

Colorado River States Discuss Boulder Dam Power

Representatives of California, Arizona, Colorado, Nevada, New Mexico, Wyoming and Utah met on Aug. 28 in Salt Lake City to confer on power permits and the cost of electricity to be generated by the Boulder dam project on the Colorado River.

The majority approved a resolution urging the Secretary of the Interior to adopt a policy of selling the power generated at a fair market price—not a cost price—as a means of building up a fund for paying for the construction costs and improvements of surrounding lands. California opposed this attitude, holding that a cost price was the advisable charge.

The four upper basin states signed a protest, to be forwarded to President Hoover and Secretary of the Interior Wilbur, against granting any power permits along the Colorado River until the upper and lower basin states have ratified a compact as to distribution of power rights between these two groups. Representatives of these four states agreed to meet in Denver Nov. 5 to seek a compact for division of their share of the river waters.

Votes to Retain City Manager

Portland, Me., at an election on Sept. 9, voted by a margin of 494 in a total of 14,290 to retain its council-manager form of government rather than to revert to the former non-partisan mayoral system.

Everglades Flood-Control and Drainage Boards Organized

The newly appointed flood-control and drainage boards of the Everglades district in Florida met Sept. 4 at West Palm Beach with Gov. Doyle E. Carlton for organization. Governor Carlton is by law chairman of both boards. Howard W. Selby, West Palm Beach, was named vice-chairman of the flood-control board, and William Griffis, Okeechobee, was appointed temporary secretary. Marcus A. Miliam, Miami, was named vice-chairman of the board of commissioners of the Everglades drainage district. Administrative offices of both boards will be maintained at West Palm Beach. The drainage commissioners will also have offices at Tallahassee, where alternate meetings will be held. Engineering and construction offices of the flood-control board will be established at Okeechobee.

Aerial Survey to Be Made of Ohio River

An aerial survey of about 78 miles of the Ohio River in the Pittsburgh district for mapping purposes will be made soon, the contract having been let this week by Col. Jarvis J. Bain, Corps of Engineers, to the Aerial Surveys of Pittsburgh, Inc. Ground surveys will also be made, and the results of the two surveys will be co-ordinated in map form. Upon these maps recommendations for further improvements of the river in the district will be based.

The airplane will fly at an altitude of about 14,400 ft. The resulting photographs will be on a scale of about 1 in. to 1,200 ft. These will be enlarged to twice this size, or to a scale of 1 in. to 600 ft. Bids for the aerial survey were made by ten concerns, as follows:

Robert H. Hunter	$11.11
Aerial Surveys of Pittsburgh, Inc.	15.33
Aerial Surveys, Inc.	17.33
Bowman Park Aero Co.	18.65
Brock & Weymouth, Inc.	19.35
Curtiss Flying Service, Inc.	21.75
Chicago Aerial Survey Corp.	24.27
A.B.C. Aerolone Corp.	29.80
Airway Corporation of America	30.00
Fairchild Aerial Survey, Inc.	38.69

State Engineering Examiners Meet in Yellowstone Park

The National Council of State Boards of Engineering Examiners held its tenth annual convention in Yellowstone National Park, Aug. 26-28, with sixteen of the nineteen member states represented by delegates. Much of the time was spent in sightseeing, but at the business sessions a number of problems were brought before the convention by the state boards of examiners of states having registration laws and some important rulings were made, among the most important of which were:

That the term "registration" is preferable to the term "licensing"; that engineers should be registered as professional engineers and classified according to the branch in which they are most proficient; that all engineers connected with corporation or engineering

organizations or employed by state governments or its subdivisions and engineers employed by railroads or interstate public service corporations who are in responsible charge of design or construction should be required to register.

Co-operation with the Am.Soc.C.E. in its study of the question of the registration of engineers was promised and the suggestion that there be a uniform registration law for professional engineers was indorsed.

The officers elected were: president, C. J. Massie, of Lynchburg, Va.; vice-president, John A. Whitney, of Cheyenne, Wyo.; secretary-treasurer, T. Keith Legare, of Columbia, S. C.

Richmond, Va., was chosen as the place for the next annual meeting, to be held in October, 1930.

U.S. Assumption of State Rights Condemned at Meeting

Regulatory authorities from 43 states at the annual convention of the National Association of Railroad and Utility Commissioners, held at Glacier National Park, Mont., Aug. 27-30, went on record as opposing all federal encroachment on state rights, particularly in connection with the Couzens bill now before Congress providing for a new federal commission to control electric power, radio and telephone companies engaged in interstate transmission. However, the association voted to support another so-called Couzens bill (formerly the Parker bill), to regulate interstate bus operation by national law. Members of state commissions, the Interstate Commerce Commission and officers of a number of public service companies attended the convention.

A brief review of the problems of mountain railway construction and operation was given in an address by Ralph Budd, president of the Great Northern Railway. Statistics on the progress of grade-crossing elimination were presented by the committee on grade crossings elimination and protection. These indicated that "present means of affording protection have not kept pace with the needs of the public and the demands of modern methods of transportation." From the standpoint of railroad operation, grade-crossing dangers have materially increased, derailments to trains due to collisions between trains and automobiles in 1928 totaling 49, resulting in the death of 22 persons and the injury of 47.

Mexico City to Have Airport

Construction of a $200,000 airport at Mexico City is provided for in a contract recently signed between the Mexican government and the Mexican Aviation Company, according to an announcement by the U. S. Department of Commerce. Within a year, according to the contract, 125,000 square meters of runways must be paved, and a standard hangar 120 ft. square and workshop 120x20 ft. erected.

Engineer Celebrates 40 Years of Chicago City Service

On his 40th anniversary in the employ of the city of Chicago, Sept. 3, 1929, Thomas G. Pihlfeldt, consulting engineer for the bridge division of the bureau of engineering, Department of Public Works, was entertained at luncheon by his fellow engineers of the bridge division, who also presented him with a silver vase suitably inscribed. For the greater part of this period Mr. Pihlfeldt has been connected with the bridge division and was city bridge engineer until 1928, practically all the numerous bascule bridges built by the city over the Chicago River during the past 25 years having been designed and constructed under his supervision.

Permission Given for New Tunnel Between New York and Brooklyn

The Secretary of War has approved the application of the Board of Transportation of the city of New York to construct a tunnel under the East River between Manhattan and Brooklyn from Rutgers Slip, Manhattan, to Jay St., Brooklyn. This means that bids will soon be asked for construction of the underwater link which will join the Houston St. line, now under construction, with the Brooklyn network of the new city subway system.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Good Favors Reorganization of Federal Power Commission—Railways Planning Extensions

SO IMPORTANT are the problems coming before the Federal Power Commission, said James W. Good, Secretary of War, Sept. 4, that Congress will be obliged in the near future to set up an organization that is not only impressed by the responsibility incurred in administration of the federal water-power act but which has the time to devote to the increasing amount of work involved. "I am sure," said Secretary Good, "that some action of that sort will be necessary. The three members of the Cabinet who now compose the commission cannot give the time to it that the importance of the matter demands." Secretary Good said that as a individual member of the commission he had no objection to the fullest investigation by Congress, such as that proposed by Senator Couzens, concerning the commission's activities. In view of the controversy that has arisen concerning the commission's procedure, he said, such an investigation might lead to a better administration of the law.

With reference to relieving the Cabinet members of their duties as members of the commission by the creation, presumably, of an independent organization, Secretary Good said that approving applications for licenses is "a pretty big problem to deal with." In predicting that its importance will actuate Congress to create a permanent organization, Mr. Good explained that he was expressing his own personal views and was not speaking for the commission.

Muscle Shoals Again

In an open letter dated Sept. 9, Senator Heflin, of Alabama, asked Henry Ford to enter new negotiations for the construction of a fertilizer plant at Muscle Shoals. Although the Wilson dam has been completed for many months, the Senator points out, four-fifths of the plant capacity is standing idle. He believes that Mr. Ford could do a great public service by entering into the mass production of cheap fertilizer for Southern farmers.

Mississippi Survey Progress

The main-scheme arc of triangulation which is being run along the Mississippi River from Cairo to the Gulf has now reached Memphis, according to reports received by the Coast and Geodetic Survey. It is expected that the work will be completed by early spring if the weather continues satisfactory for observations. One of the unusual features of the job is the extension of the steel observation towers to clear the high trees. These have been erected as high as 136 ft. on the Mississippi triangulation. Formerly 110 ft. was the record. More than a dozen towers are being used. Six always are in use for observations while the others are being torn down at the rear stations and being moved ahead. H. W. Hemple is the engineer in charge of the party.

Railway Extensions

The Southern Pacific Company has received authority from the Interstate Commerce Commission to lease the line of the Nevada-California-Oregon Railway extending from a connection with the Southern Pacific's Fernley branch at Wendel, Calif., to Lake View, Ore., 155 miles. This, together with the Central Pacific's line between Klamath Falls and Alturas, now nearing completion, will provide a through route between Klamath Falls and Ogden, Utah. The lease will run for one year and thereafter until terminated by either company on 30 days' notice.

Approval of the Interstate Commerce Commission of two railroad extensions to serve the oilfield in Lea County, N. M., is recommended in a proposed report by Examiner H. C. Davis on applications of the Texas-New Mexico Railway, a Texas & Pacific subsidiary, and the South Plains & Santa Fe Railway, a subsidiary of the Atchison, Topeka & Santa Fe. The projected line of the Texas-New Mexico would extend from its present terminus at the Texas-New Mexico state line to Lovington, Lea County, N. M., a distance of 70 miles. Construction cost is estimated at $1,825,000. The Santa Fe extension would run from Seagraves, Gaines County, Tex., to Lovington, a distance of 89 miles, at an estimated cost of $2,711,850. Construction by the Santa

Fe of another line, 43 miles long, extending south from its proposed extension in Lea County, was disapproved in the examiner's report. Lea County comprises an area as large as the State of Connecticut and the absence of railroad facilities has retarded development of its oil, potash and agricultural resources.

The Northern Pacific Railway has submitted for the commission's approval a proposal to construct an extension from the present terminus of its branch line at Brockway, McCone County, Mont., via Jordan to a point near Edwards, Garfield County, Mont., a distance of 87 miles. The carrier's application states that the line would serve a large agricultural area now accessible only by wagonroad.

Changes in Government Personnel

The resignation of Col. C. H. Birdseye, chief topographic engineer of the U. S. Geological Survey, has been announced by Director George Otis Smith. Colonel Birdseye is heading a private mapping company. He is a graduate of Oberlin University and has been with the Geological Survey since 1909 except during the war period, when he served in France with the Corps of Engineers. He will be succeeded by John G. Staack, who is well prepared for the position by his 25 years of service. Mr. Staack has been promoted from the position of section chief in charge of the Great Lakes Division. He is a civil engineering graduate of Wisconsin University.

Col. Glenn Smith also is to resign from his present active charge of the Eastern division of the Topographic Branch. He will, however, maintain his connection with the Survey, acting in an advisory capacity to the director and to the Secretary of Interior, particularly concerning the Southern Appalachian National Park Commission, of which he is secretary. He will be replaced by Albert Pike, who started very young in the work and has come up through the ranks during 40 years.

Col. Max Tyler, the new chief engineer of the Federal Power Commission, arrived in Washington Sept. 2 to take over the duties of his new assignment. Colonel Tyler is best known for the recently completed water system for the Capital City. During the same period, while he was serving as district engineer at Washington, Colonel Tyler reported on the hydro-electric possibilities of the Potomac. As a result of his study he reached the conclusion that the power resources of the river could be developed to advantage. For the past two years Colonel Tyler has been department and district engineer in the Philippines. He is widely known for the work he did in connection with the construction and operation of the Muscle Shoals project. In addition he served for four years on the Ohio River project. From 1913 to 1916 Colonel Tyler served with troops on the Mexican border. He also has had a tour of duty as an instructor at the army school at Leavenworth.

Personal Notes

ROBERT L. E. WARD, formerly hydraulic engineer with the Los Angeles County Flood-Control District at Los Angeles, Calif., is now associate engineer with the U. S. Engineer Office, New Orleans District.

J. E. KISSELL, division engineer of the Cleveland-Indianapolis division of the Big Four railway, has transferred his headquarters from Galion, Ohio, to Bellefontaine, Ohio.

JOHN A. BEEMER, formerly chief engineer of the Montague Water Conservation District, Montague, Calif., has sailed for Russia, where he will be employed for the next two years as construction engineer of government irrigation works, with headquarters in Tiflis.

DONALD D. CURTIS, for the past seven years assistant professor of mechanics and hydraulics at the University of Iowa, has been appointed professor of mechanics in the engineering department of Clemson College, South Carolina, to succeed Leroy Tucker, resigned.

WILLIAM M. ROSEWATER, of Cleveland, Ohio, has returned to that city from San Francisco, having completed supervising the design and fabrication of two placer mining dredges for work in the Fairbanks, Alaska, district for the U. S. Smelting, Refining & Mining Company.

J. F. COLLINS, of Long Beach, Calif., has been appointed director of the newly created state department of professional and vocational standards in California. In this capacity Mr. Collins automatically becomes registrar of contractors under the present contractors' license law.

J. R. MCLEAN, formerly maintenance engineer, Wisconsin State Highway Division, has become associated with the Eau Claire Engineering Company. Mr. McLean has been with the division since 1918 and previous to that date was county commissioner of Polk County, Wis.

Society Calendar

AMERICAN ASSOCIATION OF PORT AUTHORITIES; eighteenth annual convention, Quebec, Sept. 23-26.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; annual meeting, New Orleans, La., Feb. 11-13, 1930.

AMERICAN PUBLIC HEALTH ASSOCIATION, New York; annual convention, Minneapolis, Minn., Sept. 30-Oct. 4.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; fall meeting, Boston, Mass., Oct. 9-11.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION, Chicago; annual meeting, New Orleans, La., Oct. 15-17.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis; annual convention, Philadelphia, Pa., Oct. 14-18.

ASPHALT PAVING CONFERENCE, New York City; annual meeting, West Baden, Ind., Oct. 28-Nov. 1.

INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS, Chicago; annual conference, Jacksonville, Fla., Oct. 14-16.

NEW ENGLAND WATER WORKS ASSOCIATION, Boston; annual convention, Portland, Me., Sept. 16-18.

ROADMASTERS AND MAINTENANCE-OF-WAY ASSOCIATION, Pittsburgh, Pa.; annual meeting, Chicago, Sept. 17-19.

CONFERENCE OF STATE SANITARY ENGINEERS, Washington; annual meeting, Minneapolis, Minn., Sept. 28-30.

MISSOURI WATER AND SEWERAGE CONFERENCE, in conjunction with the Missouri Association of Municipal Utilities; Chillicothe, Ohio, Oct. 21-23. H. D. Peters, assistant engineer, State Board of Health, secretary.

SOUTHWEST WATER WORKS ASSOCIATION, Fort Worth, Tex.; annual convention, Tulsa, Okla., Oct. 14-16.

Obituary

CLARENCE A. LARNED, secretary, treasurer and director of the Asphalt Products Corporation, of Syracuse, N. Y., died in that city Sept. 1. Mr. Larned was for several years previous to joining the Asphalt corporation a wholesale lumber dealer of Phoenix, N. Y.

EDGAR STANTON BELDEN, vice-president of the George A. Fuller Company, of New York, died on Aug. 27 at his summer home in Holland, Mich. He made his home in Chicago and erected many of the best-known buildings in that city. He was 5 9years old.

HARRY FAY ROACH, architect, and formerly a railroad engineman, died at his home in St. Louis, Mo., on July 28. He was the inventor of the Roach rail-joint, now in use on several railroads, and also of a swing-rail turnout which eliminated the ordinary frog construction.

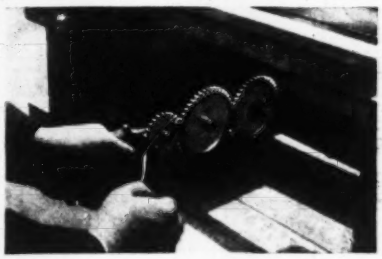
WILMER F. CHRISTIAN, SR., 98 years old, said to be the oldest contractor in the Middle West, died at his home in Indianapolis recently of heart disease. He was one of the partners in the contracting and building firm of Shover & Christian for more than half a century. The company erected one of the city's large hotels, several business and office buildings and did much other important work in central Indiana.

JOHN DAVID HURLEY, president and founder of the Independent Pneumatic Tool Company, died Aug. 15 in Chicago. Mr. Hurley was born in Simsbury, Conn., but his parents soon went West and settled in Galesburg, Ill. His early employment was with the Chicago, Burlington & Quincy and the Louisville & Nashville railways. Later he took an active part in the building of railroads in Old Mexico, where he spent several years of his early business career. About 1898 he, with his brother, Edward N. Hurley, Sr., organized the Standard Pneumatic Tool Company, one of the first concerns to introduce air tools in railroad shops and other industries. In 1902 this company was absorbed by the Schwab interests and Mr. Hurley became identified with the Rand Drill Company, of New York. In 1905 he returned to Chicago and organized the Independent Pneumatic Tool Company, with which he was associated until his death.

Construction Equipment and Materials

Wire Tightening Speeded Up by New Device

Tightening supporting and bracing wires by twisting is an old construction which is simplified by a tool developed by the Royson Manufacturing Company, Inc., Springfield, Mass. This consists

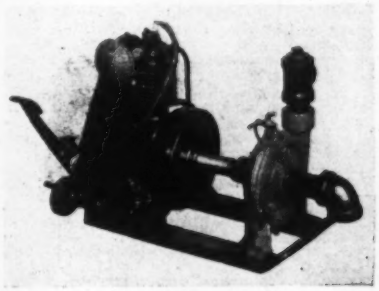


SIMPLE MACHINE TIGHTENS WIRE

of three gears mounted on a simple framework, the last of which is slotted to receive two wires. Turning the operating crank twists the wires rapidly and uniformly to any desired degree of tightness. Easy handling is provided by a pistol-grip handle. The Lightning wire twister is made in several sizes, that illustrated taking wire from eight to sixteen gage, inclusive. It weighs only 4¼ lb.

Air-Cooled Motor Drives Portable Pump

To meet the demand for a light, easily transported, self-contained pumping unit, the Union Iron Works, Inc., Hoboken, N. J., is building two sizes of the Unipump to operate under heads varying from 20 to 55 ft., with corresponding capacities of from 8,250 to 500 gal. per hour. It is claimed that these units will handle liquids containing up to 25 per cent of solids without clogging. The pumps are of the open impeller type, direct connected to Briggs & Stratton four-cycle, air-cooled engines equipped with magneto, oil pump and governor. The smaller model uses a motor developing ½ hp. at 1,750 revolutions per minute and is equipped with a foot-starter and base fuel tank. The larger unit uses a motor rating 1½ hp. at 1,800 revolutions per minute and is equipped with a rope starter, air cleaner and separate gas tank.



½-HP. MOTOR DRIVES CENTRIFUGAL DRAINAGE PUMP

Small Bulldozer for Light Work

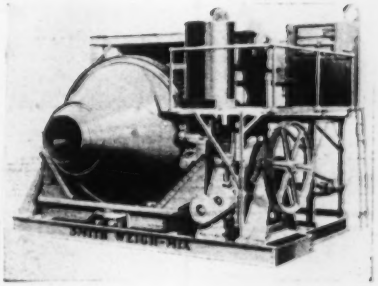
Especially designed for use with the Caterpillar Fifteen tractor, a bulldozer, made by the La Plant-Choate Manufacturing Company, Cedar Rapids, Iowa, can work economically in cramped quarters, performing such jobs as excavating, leveling around buildings, clearing sidewalks of snow and doing maintenance work for various types. The blade, 66x27½ in., is raised by means of a hand lever and worm gear.

The same company is also building a track-making wagon mounted on fore-and-aft caterpillar treads with a heaped capacity of 16 cu.yd. and a loading length of 18 ft. This is similar to the model already described in *Engineering News-Record*, May 23, 1929, p. 851, but is of larger capacity. The wagon is equipped with hydraulic winding and dumping mechanism.

BULLDOZER ATTACHMENT FOR LIGHT TRACTOR

Water and Aggregates Weighed by Proportioning Unit

Strict regulation of concrete proportions is secured by a proportioning and mixing unit developed by the T. L. Smith Company, Milwaukee, Wis., and known as the Smith Weigh-Mix. This can be applied to any standard Smith mixer and batch hopper to form a complete self-contained concrete manufacturing unit, and requires from 6 to 10 ft. less headroom as compared with the ordinary plant where overhead weighing devices are used. Separate beams are provided on the scale for weighing the coarse and fine aggregate and cement; an auxiliary scale weighs the water. The scales are set and locked by the inspector, the operator merely watching the dial pointer to know when the predetermined amount of material has been obtained. Automatic telltales give warning when this point is nearly reached. The hoppers are cleaned by

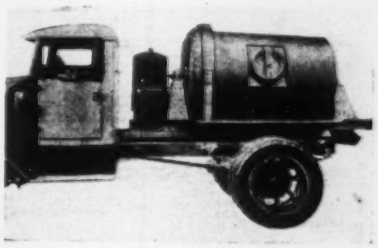


PROPORTIONING CONCRETE MIXTURES BY WEIGHT

an automatic shaking device, which also considerably increases the speed of discharge. The vibration, however, does not come into contact with the weighing mechanism. Controls are centralized for one-man operation.

Concrete Delivery Body Turned by Separate Motor

Preservation of the quality of ready-mixed concrete in transit is the object sought by the Portland Concrete Machines Company, Chicago, Ill., in the design of the R.M.C. tank body unit for use on standard heavy-duty motor trucks. This is built in four sizes, 2-, 3-, 4- and 5-cu.yd. capacities, and consists of a cylindrical steel tank mounted on an underframe supported at each end by large trunnion shafts revolving in self-aligning roller bearings. The tank is revolved by a cut-steel pinion engaging gear segments attached to the outer circumference of the tank at the front end. A Le Roi two-cylinder engine is used for rotation of the drum during delivery. Power is transferred from the motor by a chain drive. The engine is provided with eight governing speeds, so that the tank can be rotated from three to nine revolutions per minute independently of the speed of the truck itself. Loading is done through a flanged filling gate of pressed steel provided with a hinged door with



CONCRETE DELIVERY TRUCK

rubber gaskets, so that the door is hermetically sealed when closed. There is no shaft through the tank, but two sets of opposing vanes or fins are offset from the shell and run lengthwise to keep the mixture of uniform consistency and prevent separation. A discharge door is located at the bottom of the drum in the rear, being operated by a rack and pinion actuated by a hand crank. This door also is hermetically sealed with a heavy rubber gasket. An

adjustable chute immediately below the discharge door can be connected to a portable chute for discharge.

Burner Tip Removes Rivets

By the use of a special oxyacetylene rivet piercing tip manufactured by the Alexander Milburn Company, Baltimore, Md., rivets may be removed by

REMOVING RIVETS BY BURNING OUT CENTERS

consuming the head and body, leaving the remainder in the shape of a ring which either falls or is easily driven out of the metal. It is claimed that this can be done without injury to the surrounding plates and that the operation is faster than the old method of burning off the head only. The tip is specially designed in one piece and will not flash back.

Construction Noises Lessened by Silencer

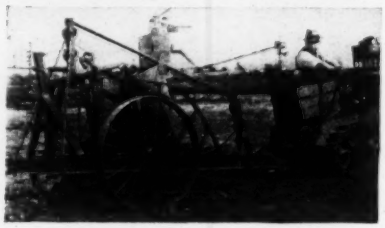
While the use of the Maxim silencer is well known in connection with firearms, it is not generally understood that this device can be used to control many sorts of machinery noises incident to construction. In fact, in the language of the Maxim Silencer Company, Hartford, Conn., manufacturer of the device, it will quiet "any noise that comes out of the end of a pipe." A recent example of its use occurred in St. Louis, where a dragline powered with a 250-hp.

SILENCER INSTALLED ON ROOF OF 250-HP. DIESEL DRAGLINE

Fairbanks-Morse diesel engine was working on a sewer through the heart of the residential district for the W. E. Callahan Construction Company. During the day the noise aroused many complaints, but when night work was commenced, bad feeling rose to such an extent that halting the entire job was threatened. The complaints were eliminated by the installation of a silencer.

Winch and Scraper for Use With Light Tractor

New equipment for use with the Caterpillar Ten tractor, developed by the Miami Trailer-Scraper Company, Troy, Ohio, includes a power winch and a scraper carrying a ¾-cu.yd. rounded load. The scraper has roller-bearing-mounted high wheels supporting a bowl of ⅜-in. high-carbon steel with sharpened cutting blade, the height of which is controlled by means of the winch mounted on the rear of the tractor. The one-piece main casting of the winch is mounted directly on the tractor housing and is connected by means of bevel and spur gears, a shaft and a splined coupling to the drive shaft of the tractor. All gears are mounted on special alloy shafts running on heavy-duty roller bearings. The clutch is of the double-disk type, fitted with brake drum and bands, one lever controlling both power and brake. The cable drum will hold approximately 135



POWER WINCH RAISES BOWL OF SCRAPER

ft. of ⅝-in. cable. When not used in connection with the scraper the winch is available for other purposes.

The company is also manufacturing a bulldozer for use with the model 15 Caterpillar tractor similar in construction to that described in *Engineering News-Record*, March 28, 1929, p. 523.

Costs and Contracts

E. N.-R. Index Numbers

Cost			Volume		
Sept. 1,	**1929**	**207.57**	**August,**	**1929**	**290**
Aug. 1,	1929	205.91	July,	1929	320
Sept. 1,	1928	207.29	August,	1928	306
Average,	1928	206.78	Average,	1928	287
Average,	1927	206.24	Average,	1927	263
1913.....		100.00	1913.....		100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the first eight months of 1929 exceed 1928 values by 26 per cent.

(In Thousands of Dollars)

Buildings	1929	1928	Per Cent Change
Industrial.....	$375,210	$209,999	+79
Commercial.....	1,457,222	1,309,704	+11
Roads.....	386,614	448,688	—14
Other eng. construc.	676,678	429,223	+57
	$2,895,724	$2,397,614	+26
Public.....	$926,960	$907,684	+ 2
Private.....	1,968,764	1,489,930	+32
Residential building.....			—26

Business Notes

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION, Washington, D. C., will hold its 24th annual meeting in Chicago, Ill., Dec. 4-6. The program will include papers and discussions on the design and construction of streets and highways, particularly of the vitrified brick type. Attention will also be paid to regional highway planning for metropolitan areas.

CONCRETE REINFORCING STEEL INSTITUTE, Chicago, Ill., will hold its semi-annual meeting Sept. 30 to Oct. 2 at Wawasee, Ind.

WESTERN PIPE & STEEL COMPANY of California has elected as president James A. Talbot, one of the original founders and incorporators of the company in 1907, succeeding J. W. Mason, retired. The firm has plants in San Francisco, Los Angeles, Fresno and Taft, Calif., and Phoenix, Ariz.

BYERS MACHINE COMPANY, Ravenna, Ohio, has appointed P. T. Redfern general sales manager. Mr. Redfern was recently manager of the Chicago office of the Mead-Morrison Manufacturing Company.

ROME IRON MILLS, INC., Rome, N. Y., has leased its plant to the Wrought Iron Company of America. The mill organization will be retained.

ROBERT BERNER STRUCTURAL STEEL COMPANY has transferred its operations to the Indianapolis, Ind., plant of Hetherington & Berner, which company has recently been acquired.

GARDNER-DENVER COMPANY, Denver, Colo., announces that Ralph Scott, formerly sales manager of the drill division of the company, is to take charge of its London (England) office, and W. G. Agnew, until recently sales representative in Arizona, is to be in charge of the office at Lima, Peru.

New Publications

Welding—LINDE AIR PRODUCTS COMPANY, New York City, gives complete instructions for welding both cast and sheet aluminum and aluminum alloys in an 8-p. illustrated booklet.

Snow-Removal Equipment—CATERPILLAR TRACTOR COMPANY, San Leandro, Calif., has issued a series of eight booklets on various phases of the clearing of snow from highways and airports.

Electric Motors—WAGNER ELECTRIC CORPORATION, St. Louis, Mo., in bulletin 159 describes its vertical motors of all types in ratings of 1½ to 30 hp.

Quick-Setting Cement—ASH GROVE LIME & PORTLAND CEMENT COMPANY, Kansas City, Mo., issues from time to time bulletins giving job photographs and brief descriptions of projects in which completion is hastened by the use of Quikard cement.

Bilge Pumps—YEOMANS BROTHERS COMPANY, Chicago, Ill., has published an 11-p. bulletin describing its heavy-duty single and duplex bilge pumps with capacities varying from 15 to 1,000 gal. per minute under heads of from 10 to 40 ft.

Explosives—E. I. DU PONT DE NEMOURS & COMPANY, INC., Wilmington, Del., has published bulletins describing the best methods of placing the detonators in explosive charges and discussing "Density of Explosives as a Factor in Excavation and Blasting Costs."

Ready - Mixed Concrete — BLAW - KNOX COMPANY, Pittsburgh, Pa., in bulletin 1114 describes the complete service which the company renders for the design and construction of ready-mixed concrete plants. The booklet also describes the bins, matching plants, water-measuring tank and delivery bodies manufactured by the company for this service.

Material Handling—BARBER-GREENE COMPANY, Aurora, Ill., describes material handling by means of belt conveyors in the construction of buildings, sewers, disposal plants, bridges, irrigation ditches, viaducts and other construction jobs in a 28-p. booklet, "New Applications and Set-Ups."

Chlorination—WALLACE & TIERNAN COMPANY, INC., Newark, N. J., continues to distribute reprints of articles and papers on various phases of chlorination, in the waterworks and sewage fields. Among the later issues are: "Advances and Developments in Sewage Chlorination," "Reduction of Bio-Chemical Oxygen Demand by Chlorination" and "Algæ Control by Chlorination."